המועצה המדעית לישראל

BULLETIN
OF THE
RESEARCH COUNCIL
OF ISRAEL

Bull. Res. Counc. of Israel

VOLUME III DECEMBER 1953 NUMBER 3

JERUSALEM

ד. מ. ירם 1927/1.54/1500

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Volume III December 1953 No. 3

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LETTERS TO THE EDITOR

NEWS AND VIEWS

ON THE Cl^-/Br^--RATIO AND THE DISTRIBUTION OF Br-IONS IN LIQUIDS AND SOLIDS DURING EVAPORATION OF BROMIDE-CONTAINING CHLORIDE SOLUTIONS

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INTRODUCTION

The Cl^-/Br^--ratio in springs and other halogen-containing natural solutions as well as in salt deposits has been the object of many investigations (Boeke 1908; Jaenecke 1938; d'Ans and Kühn 1940; Haslam, Allbery and Moses 1950). Especially J. d'Ans has shown how the history of evaporites like the Potash beds in Germany can be elucidated by studying the Cl^-/Br^--ratio.

On the suggestion of one of us a collection of data on the Cl^-/Br^--ratio in waters of the Jordan river system was started by the Palestine Potash Co., Ltd.* and later continued by the Research Council of Israel (Yaron, Kertes and Heitner 1952, Yaron 1952). Problems connected with the nature of the Dead Sea, with the occurrence of salt structures in the area and with the identification of products in the potash industry made it desirable to complete our knowledge through further investigation of bromide-containing salt solutions and through collection of exact data of Cl^-/Br^--ratios in springs, in salt outcrops and in brines and salts derived from Dead Sea water and ocean water.

Three systems were investigated:

1) Artificial solutions containing K^+, Mg^{++}, Cl^-, Br^-.

2) Artificial solutions containing K^+, Na^+, Ca^{++}, Mg^{++}, Cl^-, Br^-.

2) Artificial solutions containing K^+, Na^+, Ca^{++}, Mg^{++}, Cl^-, Br^- in the proportions of these ions in the Dead Sea.

3) Mediterranean Sea water.

These chloride-solutions containing bromides in varying quantities were evaporated at constant temperatures and the change of the Cl^-/Br^--ratio during evaporation was observed together with the Cl^-/Br^--ratio in the salts precipitating during evaporation; thus the distribution of Br^- in solutions and precipitates at different stages of concentration could be calculated.

EXPERIMENTAL PROCEDURE

The evaporation was always carried out by stirring the solutions in open glass beakers immersed in thermostats. The evaporation process was interrupted at different stages, the solutions transferred into closed mercury sealed bottles (which were also kept in the thermostats), and brought into equilibrium with the precipitated salts by stirring.

* Now Dead Sea Works, Ltd.

Received March 5, 1953.

When equilibrium had been obtained, as confirmed by analysis of Cl^- in two different samples taken at intervals of one day, the precipitated salts were separated from the solution by filtration. The salt was dried between filter paper and was kept in a well-closed flask. An analysis of the solution and of the salt was then carried out. The amount of solution adhering to the salts could be calculated by determining those ions in the wet salts, which would not be expected to precipitate together with them. For example, in NaCl-precipitates, the Ca^{++}-and Mg^{++}-content indicates the quantity of adhering brine. In Carnallite-and Bischoffite-precipitates the Ca^{++}-content may serve to indicate the quantity of the adhering brine. Besides, the water content of the solid calculated from the analysis (in case of Carnallite and Bischoffite after deduction of water of crystallisation) is also a measure of the amount of adhering brine.

The analyses were made in the usual way: potassium was analysed by the perchlorate-method, sodium by the uranyl-zinc-acetate-method, calcium by the calcium-oxalate-method, magnesium partly by the hydroxyquinoline-method, partly by difference, chloride by the method of Mohr (or Volhard), bromide by the method of van der Meulen (1931, 1934) modified by us (Bloch, Kertes and Schnerb 1952).

1. *Solutions containing the ions K^+, Mg^{++}, Cl^-, Br^-.*

These solutions were investigated by H. E. Boeke (1908) at a temperature of 25°C and E. Jaenecke (1938), who calculated by interpolation from figures collected from literature the equilibrium of some of these solutions at 20°C. Their results show considerable discrepancies. In our experiments the solutions were evaporated at 27.5°C until the Mg^{++}-concentration reached the point where Carnallite began to precipitate. Carnallite, being birefringent, could easily be observed in a microscope with crossed polaroids. KCl (KBr), which precipitates shortly before Carnallite appears, was filtered off. Mother liquor and precipitate were analysed. Then the evaporation of the mother liquor was continued until a small fraction of Carnallite (together with Brom-Carnallite)

TABLE I

	Liquid Mole in 1000 Moles H_2O				Dry solid Mole %			
	K_2	Mg	Cl_2	Br_2	Cl_2	Br_2	C_l	C_s
1 a	6.0	73.2	79.2	0.0404	0.595	0.00007	0.0508	0.012
b	5.75	74.1	79.7	0.0404	0.476	0.000057	0.0502	0.012
2 a	6.14	74.1	76.6	3.74	0.593	0.0081	4.66	1.33
b	5.34	75.6	77.0	3.72	0.491	0.0071	4.60	1.40
3 a	6.25	74.9	70.6	10.16	0.547	0.0236	12.60	4.13
b	5.44	76.7	71.9	10.10	0.469	0.0207	12.30	4.23
4 a	6.85	73.7	67.1	13.5	0.585	0.0409	16.75	6.53
b	4.34	75.7	65.5	14.47	0.462	0.0331	18.1	6.68
5 a	6.75	75.7	62.7	19.90	0.476	0.0678	24.10	12.46
b_1	6.13	78.0	63.4	20.70	0.412	0.046	24.60	10.4
b_2	4.54	74.8	59.4	19.85	0.418	0.0483	25.02	10.4
6 a	7.02	76.1	61.6	21.4	0.501	0.0867	25.75	14.75
b_1	6.72	77.4	61.3	22.6	0.428	0.0582	26.90	12.0
b_2	6.22	77.7	60.7	23.2	0.426	0.0587	27.70	12.1

a) solid — KCl (Br)
b) solid — Carnallite (Brom-Carnallite) + KCl (Br)
All solutions are in equilibrium with the solids at 27.5°C ($5b_2$ at 15°C)

had been precipitated. This fraction was separated again and both solid and liquid were analysed.

Table I shows the results of experiments carried out in this way, with solutions differing in Br^-/Cl^--ratio. In all experiments marked "a" the solid was KCl (+KBr); in experiments marked "b" the solid was Carnallite (+ Brom-Carnallite) and KCl (+ KBr). C_l and C_s give the percentages of the mole-ratio of Br^- and Cl^- in liquid and solid respectively. So C_l and C_s respectively mean 100 Mol Br^-/(Mol Br^-)+(Mol Cl^-). This form of expressing the Cl^-/Br^- relation was proposed and used by Boeke.

In Figure 1, C_l and C_s are plotted against each other. At higher C_l values our actual figures of C_s in KCl and Carnallite are different from those found by Boeke. In Diagram 1 Boeke's figures are represented together with ours. It can be seen that curve B representing the C_s figures found by us for the Carnallite-solids coincides by chance with the curve of Boeke's C_s figures for the KCl-solids. Boeke carried out his experiments at 25°C, and we worked at 27.5°C, but it does not seem that this difference in temperature could cause such diverging results. E. Jaenecke's results derived at by interpolation differ from those found by Boeke but are in some respect nearer to those found by us. At lower Br^--contents, until $C_l = \sim 20$, he found C_s to be the same for both KCl (KBr) and Carnallite (Br^--Carnallite). Only at higher Br^--concentrations he found C_s of KCl (KBr) to be higher than C_s of Carnallite (Brom-Carnallite).

Table I illustrates also the influence of Br^- on the invariant point KCl-Carnallite. Since the "a" experiments demonstrate the equilibrium at the very beginning of Carnallite-precipitation, we can take these figures as representative for the invariant solutions. It can be seen that the higher the Br^--content, the higher are the concentrations of K^+, Mg^{++}, and of (Cl^-+Br^-) when the Carnallite-point is reached. This agrees with the findings of H. E. Boeke.

A second series of experiments was concerned with the distribution of Br^- and Cl^- in liquid and solid phases at various concentrations of Mg^{++}. Here only solutions of low concentrations of Br^- were investigated. H. E. Boeke mentions that in presence

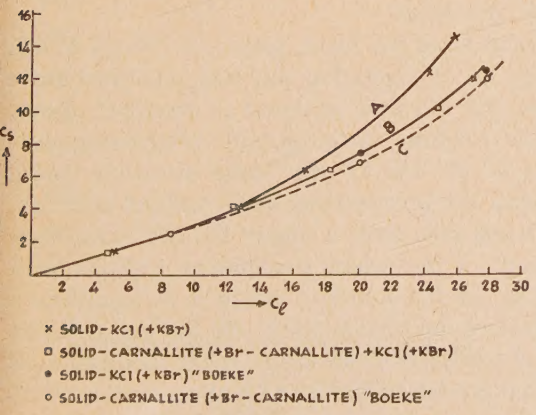

Figure 1

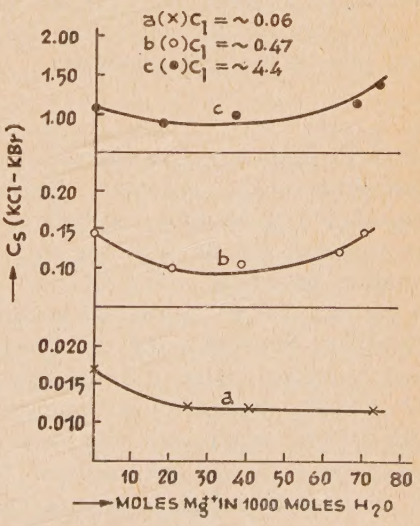

Figure 2

of Mg^{++} the precipitate of KCl contains more Br^- than in its absence. This is found true for solutions of higher Br^--concentration. At lower Br^--concentration our experiments could not confirm that such an influence exists (Figure 2). Figure 2 has C_s plotted against moles Mg^{++} in 1000 moles of water, and shows a minimum of C_s at 20—30 moles Mg^{++} at two different Br^--concentrations (illustrated by curves b and c); after the minimum, the C_s value rises in both curves in accordance with Boeke. At the low Br^--concentration (C_l=0.06) of curve "a" neither a minimum nor the rise of C_s value had been found.

For solutions like those occurring at the Dead Sea, C_l in a liquid from which Carnallite precipitates was found to be 1.49 and in the corresponding solid (Carnallite + NaCl) C_s was found to be 0.444. The figures fit very well into Figure 1 and agree with those found by Boeke and Jaenecke.

If a "primary" Carnallite (containing admixed sodium chloride), obtained by evaporation of Dead Sea water, is decomposed with water, a precipitate of solid, potassium chloride and sodium chloride, is obtained. The remaining solution is in equilibrium with Carnallite, potassium chloride and sodium chloride. By evaporating this solution one gets again a precipitate of Carnallite, called "secondary" Carnallite, also admixed with sodium chloride.

On analysing the different liquids and solids occurring during this process and calculating the Cl^-/Br^--ratio the results collected in Table II were obtained.

TABLE II

	From Dead Sea brine Cl^-/Br^-	Interpolated from Table I Cl^-/Br^-
Primary Carnallite	118	100
Equilibrium-Brine (d=1.280)	64	70
Equilibrium-Brine after evaporation (d=1.297)	57	62
Secondary Carnallite	220	228

The Cl^-/Br^--ratio shows a great difference between a "primary" Carnallite and a "secondary" Carnallite. Similarly, a "tertiary" Carnallite could be recognized by a still much higher Cl^-/Br^--ratio than that of the "secondary" Carnallite — a fact of practical value in the Potash industry.

2. *Dead Sea Brine*

Dead Sea brine as well as artificial solutions of Dead Sea brine, sp.g. — 1.185 (27.5°/4°), were isothermally evaporated. Periodically the precipitating salt was separated from the solution by filtration and both solution and salt were analysed as described above. As expected, the Br^--concentration in the solution increases with progressing evaporation beginning with a Cl^-/Br^--ratio of 42. The Cl^-/Br^--ratio decreases owing to the fact that Cl^- leaves the solution with the precipitating salts: sodium chloride, Carnallite, Bischoffite and Tachhydrite. These salts have a higher Cl^-/Br^--ratio than their respective mother liquors. The amount of Br^- which precipitates together with the chlorides depends on the amount of Br^- in the solution, which is in equilibrium with the precipitating salt, and on the nature of the precipitating salt. Sodium chloride crystallizes with very small amounts only of sodium bromide even if the concentration of Br^- in the liquid is high, owing to the fact that crystals of Na Cl and NaBr are not isomorphic in our temperature range (see H. E. Boeke *l. c.*). Carnallite and Bischoffite, however,

crystallize with considerable amounts of bromides, since these salts give an uninterrupted series of mixed crystals with the corresponding Br^--salts. Bischoffite crystallizes with still more bromide than Carnallite at the same Cl^-/Br^--ratio in the liquid.

The NaCl that precipitates in the first stage of evaporation has a Cl^-/Br^--ratio 2000—3000. As soon as Carnallite starts to precipitate with the sodium chloride, the Cl^-/Br^--ratio of the resulting solid decreases rapidly to about 100; a further sharp decrease of the Cl^-/Br^--ratio in the solid can be observed when Bischoffite also begins to precipitate (Cl^-/Br^--ratio down to 40—50).

TABLE III

Dead Sea water evaporated at 50° C

Exp.	Liquid Sp. gr.		Cl/Br	Solid Cl/Br	Nature of solid	C_l	C_s
	1.176	27.5°/4°	42.7	—	—	1.026	—
10	1.233	35° /4°	42.3	2650	small quantity of NaCl	1.027	0.0167
6	1.266	50° /4°	34.6	2700	NaCl	1.267	0.0164
6a	1.270	35° /4°	32.0	2490	NaCl	1.280	0.0178
15	1.318	50° /4°	31.4	2550	NaCl, traces of Carn.	1.395	0.0174
16a	1.329	"	29.3	98.9	NaCl, Carnallite	1.491	0.444
16b	1.342	"	28.0			1.561	
17	1.353	"	28.4	95.0	" "	1.540	0.465
17a	1.375	"	28.1	91.2	NaCl, Carnallite, traces of Bischoffite	1.553	0.485
17c	1.381	"	27.2			1.606	
18b	1.386	"	26.3	48.6	NaCl, Carnallite, Bischoffite	1.660	0.906
18c	1.392	"	24.7	45.0	"	1.765	0.976
20	1.399	"	25.4	44.0	"	1.717	0.998
20a			23.3	42.4	"	1.866	1.035
20b	1.409	"	22.5	35.4	"	1.935	1.238
21			13.3			3.23	

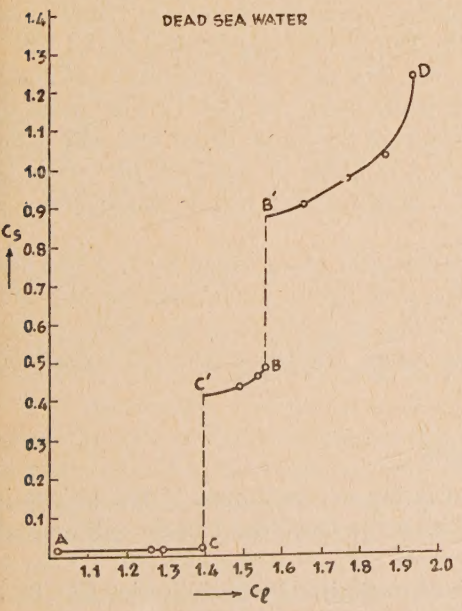

Figure 3

Table III contains the figures of the Cl^-/Br^--ratio in liquids and solids (and the corresponding figures for C_l and C_s obtained during fractional evaporation of an artificial Dead Sea brine at 50°C). The change of C_s with increasing C_l during concentration of the brine is illustrated by Figure 3. Curve A—C shows the range of NaCl-precipitation only. During the Carnallite precipitation (curve C' — B) the value of C_s rises gently. At B, Bischoffite starts to precipitate and now C_s rises during further evaporation along B' — D. At higher concentration we encountered difficulties in handling the solutions and conditions prevailing when Tachhydrite precipitates could not be investigated. It is significant that the Cl^-/Br^--ratio gives such a clear indication of the nature of the solid phases although all precipitates contained mixed

salts. Together with Carnallite considerable amounts of sodium chloride precipitated, and the Bischoffite contained Carnallite and sodium chloride.

Practically no change of the relation between Cl^-/Br^--ratios in liquid and in solid occurs with temperature variation, although the position of the invariant points changes with temperature.

3. *Mediterranean Sea water, Sp. gr.* 1.0266 (25°/4°C)

A 20 l sample of sea water from the coast of Caesarea, taken in summer 1951, was evaporated at boiling temperature until the sp. gr. of 1.138 (27.5°/4°C) was reached. Calcium sulphate precipitated when cooling to 20°C. Starting from this concentration, evaporation was continued at 27.5°C. At intervals, solids and mother liquor were analyzed. The solids contained only sodium chloride with small amounts of gypsum. The solid which had been separated from the mother liquor of sp. gr. 1.324 (27.5°/4°C) contained also magnesium sulphate and potassium chloride.

TABLE IV

Mediterranean Sea water evaporated at 27.5° *C*

Liquid		Solid		
Sp. gr. 27.5°/4°	Cl/Br	Cl/Br	C_l	C_s
1.0266	304	—	0.1456	—
1.215	264	16000	0.1675	0.00257
1.224	188	10700	0.2340	0.00415
1.231	149	5960	0.2975	0.00745
1.324	44.5	1120	0.988	0.0352

Table IV shows the Cl^-/Br^--ratio in liquids and solids and the corresponding figures for C_l and C_s. The original Cl^-/Br^--ratio in Mediterranean Sea water was found to be 304, in accordance with literature (Berglund 1885). This is much higher than the Cl^-/Br^- ratio in original Dead Sea brine (Cl^-/Br^--ratio 42). The very first precipitates of NaCl obtained by evaporation of Mediterranean Sea water show the high Cl^-/Br^--ratio of 16,000. With further evaporation the Cl^-/Br^--ratio in the liquid drops and with it the Cl^-/Br^--ratio in the solid. The last solid registered in Table IV has a Cl^-/Br^--ratio of 1120; but this solid contains only 74% of NaCl, since together with it magnesium sulphate and potassium chloride had precipitated.

Figures for the Cl^-/Br^--ratio in the solids supplement those found by J. d'Ans and R. Kühn (1940) in natural ocean evaporites. We separated and analyzed the very first and last precipitates of common salt obtained during evaporation of sea water so that our figures for Cl^-/Br^--ratio show the extreme values, whereas d'Ans and Kühn gave only averages of mixed deposits.

DISCUSSION

The results of these investigations have some bearing on the nature of the springs in the Jordan area, the Dead Sea brine, salt deposits in the Dead Sea and the salt amount of Jebel Usdum.

Generally the freshwater in the Jordan area is characterised by the following Cl^-/Br^--ratios: Lake Tiberias 100, Tiberias Hot Springs 75, Ein Tabha, Ein Tanur 100, Ein

Fuliya 150, Jordan River 100, most waters from Emek district and other sources of Galilee 250—300.

It can be taken that springs with a Cl^-/Br^--ratio near to 300 result from leaching ocean deposits in which all solid constituents of the original adhering sea water have been conserved.

Where we found higher ratios: Ein Tina (28.VI.51) 440, Ein Fuliya (3.I.52) No. 4 415, we must suppose that a deposit is leached which contains common salts in solid form more or less separated from its mother liquor. Such solid salt occurrence might be connected with oil deposits.

The Ca^{++}, Mg^{++}, SO_4^{--} and K^+ contents of these waters do not give as clear an indication of their nature as the Cl^-/Br^--ratio since they are accidentally influenced by organic life and the action of CO_2 on dolomitic limestone.

The waters of Lake Tiberias and of the Jordan River have a Cl^-/Br^--ratio of 100, which is considerably lower than that of ocean water (300). This seems possible only if an original or reconstituted mother liquor from NaCl-deposition has been leached by the hot and cold springs supplying them.

That the K^+ content of these waters in relation to Na^+ is higher than in ocean water cannot be explained by organic action, but may be understood in the same way as the decreased Cl^-/Br^--ratio.

The Cl^-/Br^--ratio of the Dead Sea brine (42) is less than half of that of its main water supply, the Jordan. Either considerable bromine quantities enter the Dead Sea by unknown subterranean sources or the Cl^-/Br^--ratio of the Jordan and perhaps the Arnon must have been considerably lower in the past.

Salt dissolved from Jebel Usdum can only have increased the Cl^-/Br^--ratio of the Dead Sea. This is proved by the fact that a number of samples taken at random from the east and west slopes of the mountain all showed a Cl^-/Br^--ratio between 3000 and 7000. This ratio is also significant for the nature of Jebel Usdum.

Since Dead Sea water can yield only salt with a Cl^-/Br^--ratio lower than 3000, the Jebel Usdum salt cannot have been formed by the evaporation of Dead Sea water with a Cl^-/Br^--ratio as it is today. It must have been formed by evaporation of a brine with a Cl^-/Br^--ratio between 110 and 150. This corresponds to the Cl^-/Br^--ratio of an ocean water at salt depositing concentration. Some of the salt (the one with a ratio 3000) might have been formed by a Dead Sea brine near to the composition of concentrated Jordan water. All this conforms with the views that Jebel Usdum is not or only partly the result of Dead Sea evaporation (Blanckenhorn, Picard 1943).

J. Haslam, E. C. Allberry and G. Moses (1950) investigated the Cl^-/Br^--ratio in common salt deposits in Cheshire. The Cl^-/Br^--ratio there was found to be between 1012 and 6879, similar to the results of Jebel Usdum.

It is noteworthy that 0.5 m thick layers of a salt deposit found some three metres below the mud covering substantial areas of the bottom of the Dead Sea at its southern end showed a Cl^-/Br^--ratio of only 2500, which suggests that these salt layers really originate from the Dead Sea water as it is today. If these salt strata prove to be extensive, then their crystallisation from Dead Sea brine might have removed enough of the Cl^- brought by the Jordan River to leave the Dead Sea at our present state of comparatively low Cl^-/Br^--ratio.

The Cl^-/Br^--ratio gives not only an indication on the history of salt deposits in na

ture but also of the history of deposits of salt and potash ores in artificial evaporation ponds; i. e. the fact that carnallite which has been deposited from virgin Dead Sea water has an entirely different Cl^-/Br^--ratio than carnallite which has been formed in ponds by evaporating factory effluents, can be used for control of the potash refining process.

ACKNOWLEDGEMENT

We wish to thank Dr. F. Yaron for helpful discussion, Mr. A. Modiano and Miss M. Heitner for helping in carrying out the analyses, and the Hydrological Service of the Israel Government for supplying us with water samples.

REFERENCES

1. Berglund, E., 1885, *Ber.*, **18**, 2888.
2. Blanckenhorn, M., *Naturwissenschaftliche Studien am Toten Meer und im Jordantal*, Berlin, R. Friedlaender & Sohn, p. 115—116.
3. Bloch, M. R., Kertes, S. and Schnerb, J., 1952, *Bull. Res. Counc. of Israel*, **1**, 82.
4. Boeke, H. E., 1908, *Zeitschrift f. Kristallogr.*, **45**, 346.
5. d'Ans, J. and Kuhn, R., 1940, *Kali, Verwandte Salze & Erdoel*, **34**, 426.
6. Haslam, J., Allberry, E. C. and Moses, G., 1950, *The Analyst*, **75**, 452.
7. Jaenecke, E., 1938, *Zeitschr. Elektrochem.*, **44**, 185.
8. Picard, L., 1943, *Structure and Evolution of Palestine*, Jerusalem.
9. van der Meulen, J. H., 1931, *Chem. Weekblad*, **28**, 82, 238; *ibid.*, **31**, 558.
10. Yaron, F., 1952, *Bull. Res. Counc. of Israel*, **2**, 121.
11. Yaron, F., Kertes, S., and Heitner, M., 1952, *Bull. Res. Counc. of Israel*, **2**, 118.

THE EFFECT OF DIFFERENT FACTORS ON THE ASCORBIC ACID CONTENT IN CITRUS FRUITS

1. THE DEPENDENCE OF THE ASCORBIC ACID CONTENT OF THE FRUIT ON LIGHT INTENSITY AND ON THE AREA OF ASSIMILATION*

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Ramat Gan

INTRODUCTION

Citrus fruit, which is the main export item of this country, is dispatched for the most part as fresh fruit. A considerable part of the crop is, however, exported in the form of concentrates. This product is bought principally by the British Government, and serves to meet the vitamin C requirements of the population in England, especially of the children. The object of this research was to study the effect of different factors on the vitamin C content in citrus fruits grown under local conditions.

There is general agreement in the literature published on the subject (Hamner and Maynard 1942, McCollum 1944, Somers and Beeson 1948) that the ascorbic acid content is influenced to a very considerable extent by light intensity. In the absence of light the ascorbic acid content in plants drops to very low levels (Somers and Beeson 1948). The vitamin C concentration is lower in plants which grow during the winter months than in those growing in summer (Hamner and Maynard 1942, Mentzer and Fatianoff 1949) owing to the differences in light intensity. The quantitative relationship between light intensity and vitamin C content has also been investigated (Aberg 1946, Somers, Kelly and Hamner 1948). As far as citrus fruits are concerned the research was almost entirely confined to determining the difference between fruit in the sun and in the shade (Harding and Thomas 1942, Winston and Miller 1948) and the variations in ascorbic acid content according to the aspect of exposure (Sites and Reitz 1950, Smith and Caldwell 1944).

The nature of the effect of light on the formation of ascorbic acid has not yet been fully clarified. The decisive influence of light on the biosynthesis of vitamin C on the one hand, and on the assimilation process on the other, as well as the great similarity between the molecular structure of hexose and of ascorbic acid, gave rise several years ago to the hypothesis that there is a causal relationship between those two constituents, but no definite proof has been provided. Whereas certain investigators suggested that the vitamin C was produced upon the chloroplasts at the time of assimilation, others maintained that the assimilation products form the raw material for the production of vitamin C, but not necessarily at the site of assimilation. There are also conflicting opinions in the available literature concerning the question whether the vitamin C con-

* From a thesis submitted to The Hebrew University of Jerusalem in partial fulfilment of the requirements for the Ph. D. degree.

Received August 2, 1952.

tent of the fruit is determined by the intensity of light which falls on the fruit itself (Anonymous 1948) or the light intercepted by the leaves (Robinson 1949).

The aim of this work was to ascertain to what extent the vitamin C content of citrus fruit is influenced by differences in light intensities prevailing in the local fruit groves and whether the vitamin C content of the fruit depends on the light falling directly on the fruit or that falling on the leaves.

METHODS AND MATERIALS

Samples consisting of 25 fruits per tree were picked at random from the four cardinal sides of the tree, in accordance with a previous investigation (Samisch and Cohen 1949), and included fruits from both the top and the central part of the crown.

The method of preparing the fruit for examination has already been described by Samisch and Cohen (1949), but in the present study the rag was separated from the peel by means of a stainless steel knife, before determination of the peel composition. For the determination of the sugar and dry matter content, the peel was chopped up in a meat grinder, and for the ascorbic acid tests, strips 3—5 mm thick were cut from the peel and ground in a Waring Blendor, in the presence of a 0.4% oxalic acid solution to prevent the action of ascorbic acid oxidase (Loeffler and Ponting 1942).

The ascorbic acid was examined by means of titration with 2,6-dichlorophenol-indophenol (D. C. P. I.) at the pH of the fruit juice or at that of the oxalic acid extract. The vitamin C in the juice was found by Bessey (1944) to be entirely in reduced form as verified by our tests. According to the research of the Biochemical Department of the Hebrew University (not yet published) it was found that the vitamin C in orange peel also appears solely in the form of ascorbic acid, and that the partial occurrence of the dehydrogenated form is to be attributed to faulty preparation which does not result in the immediate destruction of ascorbic acid oxidase upon crushing.

Examination of eight samples of orange peel strips in oxalic acid revealed small differences between the values before and after reduction with hydrogen sulfide, those after reduction being on the average 7.5 percent higher. As is known, after reduction the turning point in titration is less clearly defined, and substances are actually formed which reduce D. C. P. I., but are not necessarily ascorbic acid (Aussen e. a. 1950, Guenther 1944). Samples of peel were therefore tested for Vitamin C also without reduction with hydrogen sulfide.

The content of total soluble solids, the sugar and acid content of the juice and also the sugar and dry matter content of the peel were determined by methods described by Samisch and Cohen (1949).

For the studies on the direct effect of light on the fruit, twin fruits arising from a common spur were selected, since the ascorbic acid content of such pairs is usually very similar, differences rarely exceeding 2.5 percent. In each case one of the fruits was enclosed in a sleeve of black cloth with ends sewn up loosely to allow the exchange of gases, while the second fruit served as a control. The black sleeves were, in turn, wrapped in white cloth. This procedure prevented the rise of temperature within the sleeves, which in the absence of the white wrapping may amount to as much as 10°C.

The fruit was covered in two seasons at the beginning of October, and in another season in the middle of August. The considerations which determined the time of wrap-

ping were determined on the one hand, by the liability of the young fruit to drop as a result of severe changes in environmental conditions and, on the other hand, by the fact that the most intensive accumulation of ascorbic acid takes place between about mid-September and the beginning of December.

In order to reduce the quantity of light falling on the leaves, the branches were wrapped in a loosely woven white cloth which reduced the light intensity by 84 percent. The branches, which were ringed at their base, were covered in such a way as to leave the fruits exposed. The covering of the foliage was carried out at the end of July 1950.

For the studies on the effect of the ratio of the number of leaves to the number of fruits on the ascorbic acid concentration in the fruit, boughs were selected which divided off into two branches approximately $^3/_4$ to $1^1/_2$ cm in diameter. Each of the branches was ringed at the base to a width of 4 mm in order to cut off the supply of assimilation products from other parts of the tree. One of the branches was partially defoliated, the leaves adjoining the fruits being retained in order that the fruit should be subjected to the normal light intensity. In the years 1947 and 1950, the foliage was thinned out from mid to end October, and in the year 1949 at the end of August.

The number of leaves per fruit is normally at least 50 and usually more. After thinning the foliage, only 4—10 leaves were left per fruit. Shamel and Pomeroy (1934) determined that for normal growth of the Valencia orange, about 50 leaves per fruit are necessary.

RESULTS OF THE EXPERIMENTS

a. Ascorbic acid content according to the location of the fruit on the tree

The quantity of light received by the fruit varies greatly — not only between the peripherial and the inner parts of the tree crown, but also, as far as the outside of the tree is concerned, according to the direction faced. Monselise (1950) found that the light intensity on the south side of a Shamouti tree is on a yearly average $3^1/_2$ times that on the side facing north. The vitamin C content of the juice was therefore determined in fruits taken from the four cardinal directions of the periphery, as well as from the top and the centre of the crown.

These tests were carried out on different varieties of citrus fruit and at different times. The results are summarized in Table I where the data for each location represent the average of the values obtained for the trees examined. These results show that, in spite of considerable differences in the light intensity prevailing on different sides of the tree, the differences in the ascorbic acid content of the fruit taken at the different points are relatively small. Even in a square-planted grove there is no fixed relationship between vitamin C content of the fruit and the aspect of the tree. The highest ascorbic acid content is found at the top of the tree which is exposed to light during most of the day and it is generally lowest in fruit taken from the centre of the tree. In the latter it amounts to between 85—98 percent of the former, the average being 91.6 percent. According to Mendel (1952) who, in the same experiments, examined other properties of the fruit, the relative total soluble solids content of inner fruit in relation to outer fruit varied between 92—98 percent, with an average of 95.5 percent.

TABLE I

The effect of the position of fruit on the tree on the ascorbic acid content of the juice (mg per 100 ml).

Date of examination	Variety	Number of trees	Position on tree						Difference	
			North	West	South	East	Top	Centre	Signif.	Highly signif.
4.11.47	Shamouti I	6 *	46.7	48.8	49.5	50.5	51.0	48.3	1.9	2.5
8. 1.48			43.0	45.2	45.0	43.3	46.3	43.7		
4.12.49	Shamouti II	4**	44.5	43.5	46.0	46.0	47.5	40.5	4.6	7.6
14.10.49	Shamouti III(*)	1**	51.6		51.0		52.6	45.5	2.5	3.4
12. 2.48	Valencia	2***	73.5	75.5	76.0	75.3	75.9	68.3	5.6	8.8
13.11.47	Grapefruit	2***	47.6	46.8	47.0	45.4	48.2	46.0	2.3	

* Direction of rows: north — south. Distance 3 m between trees and 6 m between rows.
** Direction of rows: east — west. Planting distances as above.
*** Distance of 5 m in both directions.
(*) Every fruit was examined separately, 10 fruits from each aspect.

In experiments in which exposed oranges were tested against covered oranges (see Table III), a comparison was also made between fruit taken from the outside of the tree and that originating from within the crown. The relative ascorbic acid content of the inside fruit, expressed as a percentage of that found in the outside fruit, was on the average 84% in the juice and 82% in the peel. The relative total soluble solids content of the juice averaged 93%. In these experiments the outer and inner fruits were carefully selected, and thus the differences in their composition were greater than in those previously recorded. In several tests performed during February 1948 and March 1950, the inner fruits were specially picked from shady positions. Under these more extreme conditions, the relative ascorbic acid content in the juice varied between 75% and 79%, and in the peel between 68% and 76%.

The ascorbic acid content of inner and outer leaves, as measured on 11.5.1950, was 180 mg% and 391 mg% respectively.

The above results indicate that the differences in the ascorbic acid content of the juice, as determined by the position of the fruit on the tree, do not generally exceed 10% although in extreme cases they may reach 25%. The sugar content of the juice is affected by the position of the fruit to a lesser extent. The position of the fruit affects the ascorbic acid content of the peel to a somewhat greater extent than that of the juice. The sensitivity of the leaves to changes in light intensity, as expressed in the ascorbic acid content, is particularly pronounced.

b. The effect of grove thinning on the ascorbic acid content of the juice

In the older, overcrowded groves a large proportion of the fruit grows under conditions of low light intensity. The Citrus Department of the Rehovot Agricultural Research Station studied the effect of thinning such groves on the yield and quality of the fruit. In one of these groves, where the rows run north to south, every second row was removed from one plot, while a neighbouring unthinned plot was retained as a control. A comparison of the juice composition of fruit taken from the east side of the trees in these two plots showed that the removal of alternate rows gave rise to a 12% increase in the ascorbic acid content of the fruit, and a 4% increase in total soluble solids. These results parallel those obtained from the examination of fruit taken from the shady and exposed sides of the same tree.

c. Ascorbic acid content of fruit affected by sunscald

For three years, at the beginning of the season, the composition of halves of Shamouti fruits affected by sunscald was examined against that of the undamaged halves. The average results of the tests carried out on individual fruits are shown In Table II.

TABLE II

The effect of sunscald on the composition of Shamouti oranges. Comparison between the damaged and the healthy half of the fruit.

Number of fruits	Date of examination	Juice						Peel			
		Ascorbic acid (mg/100 ml)		Total soluble solids (%)		Citric acid (%)		Ascorbic acid (mg/100 g)		Total sugar (%)	
		h	d	h	d	h	d	h	d	h	d
5	2.11.47	46.6	51.9	10.2	10.0						
8	2.12.49	50.3	54.1	10.5	9.9						
5	26.10.50	52.0	59.4	10.5	10.3	1.13	0.94	53	141	6.92	7.40

d = damaged half; h = healthy half.

The results show that fruit pulp on the side affected by the sunscald contains on the average 11% more vitamin C, 3% less soluble solids, and 17% less citric acid, compared with the healthy side. In the peel, the difference in ascorbic acid content between the two sides of the fruit is particularly marked, while there is only a small difference here in the sugar content.

A comparison of the composition of the outward half with that of the half facing the tree in fruits unaffected by sunscald did not reveal any consistent differences.

d. The dependence of ascorbic acid content of the fruit on weather conditions

It has been shown (Reid 1942) that the vitamin C content of various vegetables depends on weather conditions and that short periods of bright or cloudy weather exert a marked influence. In order to determine whether this also applies in the case of oranges, 24 fruits from each of two trees were examined on 12.11.47, after three rainy days. The test was repeated for the same trees in the afternoon of 16.11.47, at the close of four days of clear weather, and again early the following morning. The ascorbic acid content was found to be 43.1, 43.5 and 43.5 mg per 100 ml respectively, for the three tests in chronological order. The results prove that a period of three to four days of extreme weather conditions has no effect on the vitamin C content of the fruit pulp, nor does the content of this constituent vary as between the morning and the afternoon.

e. The effect of exclusion of light from fruit on its composition

In the middle of August 1949, inner and outer fruits were wrapped in black cloth, and their composition was compared with that of exposed fruits at the end of December. Five pairs of fruit were examined in each test. When this experiment was repeated at the beginning of October 1950, part of the fruit was covered only with a black sleeve while the other part was enclosed in an additional wrapping of white cloth. Outermost and innermost fruits were carefully selected, to represent the canopy and the crutch region respectively. These results are summarized in Table III.

TABLE III

The effect of exclusion of light from Shamouti oranges on their composition

Season	Position of fruit on tree	Kind of covering *	Average weight of fruit (g)	Juice			Peel		
				Ascorbic acid (mg %)	Total sol. solids(%)	Citric acid (%)	Ascorbic acid (mg %)	Sugar (%)	Dry matter (%)
1949—1950	Canopy	None	295	44.4	9.7	1.46	116		
		B.	280	41.1	9.1	1.36	43		
	Centre	None	283	37.4	8.9	1.36	96		
		B	292	32.6	8.8	1.34	35		
1950—1951	Canopy	None	225	37.8	10.1	0.83	118	8.41	22.2
		B.	204	34.1	9.4	0.74	38	7.34	21.2
	Canopy	None	225	37.8	10.3	0.88	141	9.88	
		B.W.	243	34.7	9.7	0.84	43	8.19	
	Centre	None	224	31.8	9.5	0.98	84	8.38	21.6
		B.	207	32.1	9.3	1.01	39	7.68	20.7
	Centre	None	209	31.9	9.9	1.01	94	10.21	24.5
		B.W.	206	29.8	9.4	0.95	45	9.74	22.7

* B — black sleeves only.
B.W. — black sleeves enclosed in white cloth.

Fruits developing in the absence of light during the latter months of their ripening, contained 10% less ascorbic acid than those developing under normal conditions. Covering the fruit causes a fall in the content of total soluble solids and of citric acid, whereas the overall weight of the fruit remains unaffected. The differences in the ascorbic acid and total soluble solids content between covered and exposed fruit are highly significant according to analysis of correlated samples by Student's method. The low values for the ascorbic acid content in the peel of the covered oranges are very marked, the exclusion of light resulting in an average drop of 60%. The sugar content of the peel drops in the absence of light by approximately 11%, while the dry matter content is not markedly affected.

It can be seen that there is no difference in the properties of fruit covered with black sleeves, as compared with those wrapped additionally in white cloth, in spite of the rise in temperature within the naked sleeves.

In spite of the fact that the difference in the light intensity between centrally located and peripherial fruit is less than that between exposed and covered fruit, the difference in ascorbic acid content of the juice is greater in the former case. The ascorbic acid content of the peel, on the other hand, is reduced to a far greater extent in blacked-out fruit than in fruit growing in a shady part of the tree. Up to December, the covering of fruit reduced the vitamin C content of the peel by 62%, whereas natural shade resulted in a reduction of 18% and 32% during the two seasons under discussion. The soluble solids content is rather similarly affected in both instances. Whereas the citric acid content drops in the absence of light, it is generally higher in inner than in outer fruits.

f. The effect of partial exclusion of light from leaves on the composition of the fruit

On most of the branches which had been wrapped in white cloth, while leaving the fruits exposed, the foliage withered and the fruit dropped off; only on one branch did most of the leaves and fruits remain in good condition. Table IV is based on the analysis of 7 fruits taken from this branch and 8 fruits derived from an adjoining control branch. The partial failure of this experiment may possibly be attributed to the fact that the branches were wrapped too early in the season (July). The results supported by such limited data must be treated with great reserve and can only serve as a preliminary indication.

TABLE IV

The effect of reduction of light falling on leaves upon the composition of the fruit
(Covering of leaves in July, examination of fruit 5.10.1950)

Branch	Weight of fruit (g)	Composition of juice			Composition of peel	
		Ascorbic acid (mg%)	Tot. sol. solids (%)	Citric acid (%)	Ascorbic acid (mg%)	Sugar (%)
Uncovered	123	40.4	9.7	1.82	65.0	5.85
Covered	83	42.0	9.3	1.43	46.4	4.10

The inhibitory effect of the cloth covering on the formation of assimilation products in the leaves not only delayed the growth of fruit, but also resulted in a reduction in the sugar and ascorbic acid contents of the peel. As opposed to the changes which took place as a result of fruit shading, a reduction in the intensity of light falling on the leaves is followed by a parallel drop in both the sugar and the ascorbic acid contents of the peel. In this case also, the content of the constituents of the peel changes to a far greater extent than that of the juice. In the juice, only the citric acid content is markedly affected by the reduction of light intercepted by the leaves.

g. The effect of the reduction of the leaf area per fruit on the fruit composition

Experiments on the effect of reduction in the number of leaves per fruit on fruit composition were carried out during three seasons, but since almost identical results were obtained in all the tests, the results for the season 1950—1951 alone are given in Table V.

TABLE V

Effect of reduction in number of leaves per fruit upon fruit composition

Date of examination	Number of fruits examined	Number of leaves per fruit	Average weight of fruit (g)	Composition of juice			Composition of peel		
				Ascorbic acid (mg/100ml)	Tot. sol. solids (%)	Citric acid (%)	Ascorbic acid (mg/100 g)	Total sugar (%)	Dry matter (%)
9.1.51	8	Normal*	198	36.0	11.3	1.08	150	10.96	
	7	5	182	33.9	9.5	1.02	95	5.04	
18.1.51	7	Normal	208	34.2	11.0	1.08	170	10.44	25.2
	5	6	178	32.3	9.0	1.06	109	4.87	19.3
30.1.51	9	Normal	190	39.2	11.9	1.02	172	10.57	26.0
	5	10	152	36.4	9.8	1.00	100	4.95	20.5
31.1.51	7	Normal	242	41.6	11.5	1.04	191	10.36	25.1
	9	4	227	37.9	9.4	1.01	128	4.92	19.4

* Normal — at least 50 leaves per fruit.

As might have been foreseen, the reduction of the leaf number per fruit had a similar effect on the composition of the fruit as the reduction of light received by the leaves. Both in the peel and in the pulp, reducing the areas supplying assimilation products to the fruit had a more pronounced influence on the carbohydrate content than on the ascorbic acid content. The ascorbic acid content of the peel dropped on the average by 37 %, whereas the drop in the soluble sugar content averaged 53%. In the juice the average percentage reduction amounted to 17% for soluble solids and 7% for ascorbic acid.

Since the percentage drop of dry matter in the peel is virtually equal to that of sugar, it would seem that there are practically no changes in constituents other than soluble sugars. The absolute amount of those constituents of the dry matter is, however, reduced by the curtailment of the assimilating area, since the weight of the fruit is less than in the control group (on the average by 14.5%).

DISCUSSION

The results obtained can be most satisfactorily explained by the assumption that the ascorbic acid is formed by the action of light rays in the peel of the fruit from assimilation products transferred from the leaves, and then passes from the peel to the fruit pulp. Although most of the sugar in the fruit is derived from the leaves, a smaller amount is formed in the fruit peel itself.

A number of different hypotheses have been put forth concerning the actual place of formation of vitamin C. One of these postulates that the vitamin C is formed in the leaves and from them it is transferred to the fruit (Wokes and Melville 1948). If it were so, then a reduction of the leaf area should proportionally reduce the sugar and ascorbic acid content of the fruit. This hypothesis is also incapable of explaining the great drop in the vitamin C content of the peel in covered fruit. It would appear from our results that the sugar is brought mainly from the leaves to the fruit, since a reduction of the assimilation area due to partial defoliation reduces very appreciably the sugar content of the fruit. Nevertheless, there is also a certain drop in the sugar content of covered fruit even though the leaves receive normal light. This reduction is apparently caused by the cessation of local assimilation in the chloroplasts of the peel.

Aberg (1946) maintains that the formation of the ascorbic acid in the tomato fruit mostly takes place in its outer part and is dependent on the chlorophyll of the fruit. This is obviously not the case with oranges, since every factor which reduces the amount of assimilation products in the leaves, also results in reduced ascorbic acid content of the fruit. The assimilation capacity of the orange fruit is apparently limited, for the exclusion of light from the fruit brings about only a small drop in its carbohydrate content. The assimilation potential of the fruit is also restricted by the small number of stomata per area unit (Turrell and Klotz 1940). It should also be noted that the accumulation of vitamin C continues at an appreciable rate, especially in the peel, even when the amount of chlorophyll in the peel is already decreasing.

In support of our hypothesis concerning the metabolism of ascorbic acid the following points may be noted:

(a) It has been shown that any change in environmental conditions brings about

considerably greater variations in the ascorbic acid content in the fruit peel than in the pulp.

(b) The formation of ascorbic acid in mature plants depends first and foremost on the presence of light. Thus, if there is any formation of ascorbic acid in the fruit, it can only take place in the peel which is exposed to light.

(c) Avidor (1950) showed that the concentration of ascorbic acid oxidase in the flavedo is greater than in the albedo and that the enzyme is not present in the fruit pulp. According to Rubin (1940) vitamin C is formed in tissues rich both in ascorbic acid and ascorbic acid oxidase, whereas the presence of ascorbic acid alone shows that the tissue concerned serves only as a storage place for vitamin C. It is not surprising that ascorbic acid is produced in the least sour tissue, for Mapson and Cruickshank (1947) found that those salts which raise the pH in the tissues of *Lepidium sativum* seedlings also speed up the formation of ascorbic acid.

(d) The drop in vitamin C content from the flavedo inwards strengthens the assumption of its centripetal flow. This directional drop comes, however, short of fully accounting for the flow, for very marked changes in the ascorbic acid content of the peel are associated with disproportionately small changes in the fruit pulp, although the inward gradient is always in evidence. It would seem therefore that there are additional forces at play which control the transfer of vitamin C from the peel to the pulp. It may be assumed that during the period of rapid growth of the fruit pulp petween August and December, ascorbic acid is transferred from the peel inwards, in spite of changes in the concentration gradient which render speedy translocation more difficult.

(e) Examinations of the seasonal changes in vitamin C content of the fruit (results not yet published) have made it possible to calculate by means of interpolation in the 1950/51 fruit-covering experiment the quantity of ascorbic acid in the different parts of exposed and covered fruits, both at the time of covering and at the time of picking. The results of this calculation, shown in Table VI, can, of course, only be expected to provide a rough approximation to reality.

TABLE VI

Average amount of ascorbic acid in different parts of exposed and covered Shamouti oranges (mg)

Date	7.10.1950	17.12.1950	
Examined material	Exposed	Covered	Exposed
Pulp segments	39.0	48.7	55.2
Peel	40.9	29.7	97.1
Whole fruit	79.9	78.4	152.3

Whereas under normal ripening conditions the amount of ascorbic acid doubles within two months, it hardly undergoes any change in covered fruit. In exposed fruit the principal rise in ascorbic acid content takes place in the peel, whereas in the wrapped fruit, the ascorbic acid content increases in the pulp — although to a lesser extent than in the exposed fruit — while it falls in the peel. It is not to be assumed that the additional vitamin C in the pulp of covered fruit comes directly from the leaves, for if it were so, the reduction of the number of leaves should result in a considerable drop in the ascorbic acid content of the pulp, which is not found to be the case. It would

seem that the figures in Table VI may best be explained by the assumption that in blacked-out fruit the formation of ascorbic acid within the peel is completely arrested due to the absence of light, while the flow towards the pulp continues, though at reduced rate.

The fact that the difference in ascorbic acid content of the juice is greater between outer and inner fruit than between exposed and covered fruit — and this in spite of the fact that in the second case the difference in light intensity is greater — in combination with the fact that in the first instance there is also a corresponding difference in the light received by the leaves concerned, would seem to indicate that the ascorbic acid in the fruit pulp comes for the most part directly from the leaves. It should, however, be remembered that in the case of fruit growing inside the crown of the tree, both the fruit and the associated leaves grow constantly under the specific conditions of low light intensity. In wrapped fruit the quantity of vitamin C formed during the period of the experiment is 60 percent of that formed in exposed fruit (see Table VI), whereas in inner fruit the quantity formed is 84 percent of that in outer fruit (Table IV). In addition, the situation is confused by the flow of ascorbic acid from the peel to the pulp. It should therefore not be assumed on the basis of the above facts that there is a direct flow of ascorbic acid from the leaves to the fruit pulp.

The hypothesis that the vitamin C is formed in the external tissues of the fruit and is transferred inwards, has already been put forward by Willimott and Wokes (1926), Watanabe (1938), Hamner and Maynard (1942) and Aberg (1946), but no satisfactory proof has been provided by any of these investigators. We have no knowledge concerning the manner of transit from the peel to the fruit pulp, but it does not appear to be effected by way of conducting vessels, for no such vessels pass through the membranes of the segments.

On the basis of what has been stated above, it may be concluded that the vitamin C content of the fruit is determined both by the intensity of light received by the fruit, and that intercepted by the leaves. The latter controls the amount of assimilation products formed in the leaves which, after translocation to the fruit, provide raw material for the biosynthesis of ascorbic acid. The intensity of light falling directly on the fruit, apart from determining the restricted photosynthetic activity in the fruit, regulates the degree of conversion of the assimilation products to ascorbic acid. These conclusions contradict the assertion of Robinson (1949), based on his experiments on strawberries, that only the light received by the leaves determines the vitamin C content. They are also in disagreement with the findings of the U.S. Laboratory for Plant, Soil and Nutrition Research (1948), according to which the vitamin C content of the tomato is determined solely by the light reaching the fruit itself, and is in no way affected by the light received by the leaves. As opposed to the above, both Hansen and Waldo (1944) and Ezell et al. (1947) found that the ascorbic acid content of the strawberry is dependent both on leaf and fruit illumination.

The differences in ascorbic acid content of the juice between fruit exposed to light and shaded fruit are in rather close accord with those obtained by various investigators in Florida (Harding and Thomas 1942, Sites and Reitz 1950, Winston and Miller 1948). Only in extreme cases did the differences in Israel groves amount to 25%, while the biggest differences recorded in Florida amounted to 32%.

Systematic measurements of light intensity on Shamouti trees carried out by Monselise (1950) have shown that the light intensity at the perimeter of the tree is almost

ten times that inside the crown, whereas the extreme directional difference around the periphery — as between the north and south aspect—is not more than 72 percent. Considering that the differences in ascorbic acid content between inner and outer fruit averaged only about 10 percent, it is understandable that percentage differences in ascorbic acid content due to aspect are rather insignificant and are liable to be obscured by various other factors.

Smith and Caldwell (1944), who investigated in Arizona the vitamin C content in the juice of navel oranges, almost invariably found the lowest concentration in inner fruit. Although they found no consistent differences between different sides of the tree, they observed a certain tendency towards a lower concentration of vitamin C on the north side and a somewhat higher concentration on the west side. Sites and Reitz (1950) also found the lowest vitamin C content in fruit facing north, but failed to detect any consistent differences between the other aspects of the tree.

The very great increase in ascorbic acid concentration associated with sunscald is probably due to the intense radiation. McCollum (1944) recorded a rise in ascorbic acid content in the side of tomato fruit affected by sun-scorch.

ACKNOWLEDGEMENT

The author's thanks are due to Prof. H. R. Oppenheimer for his guidance in these investigations and to Mrs. Z. Samisch, Head of the Fruit Products Laboratory at the Agricultural Research Station, Rehovoth, who made possible the execution of the work.

REFERENCES

1. Aberg, B., 1946, Effects of light and temperature on the ascorbic acid content of green plants, *Ann. Royal Agric. Coll. Sweden*, **13,** 239.
2. Anonymous, 1948, Factors affecting the nutritive value of foods, *U.S.D.A. Misc. Publ.*, **664,** 26pp.
3. Aussen, B. S., Maassen, B., Spruyt, J. P. and Woestman, B., 1950, The usefulness of the Levy correction on the ascorbic acid estimation by the Tillmans method, *Voeding*, **11,** 65-71; *C.A.*, **44,** 3555.
4. Avidor, Y., 1950, The oxidation system of ascorbic acid in orange peel, with special reference to ascorbic oxidase, *Doctorate thesis, The Hebrew University of Jerusalem.*
5. Bessey, O. A., 1944, Report on ascorbic acid (Vitamin C) in citrus fruits and tomatoes, *Ass. Off. Agr. Chem. Jour.*, **27,** 537.
6. Ezell, B. D., Darrow, G. M., Wilcox, M. S. and Scott, D. H., 1947, Ascorbic acid content of strawberries, *Food Res.*, **12,** 510.
7. Guenther, E., 1944, Die Fehlerquellen bei der Bestimmung von Gesamtvitamin C vermittelst der H_2S-Reduktion, *Vitamine u. Hormone*, **5,** 55-61; *Nutr. Abstr.*, **18,** 592.
8. Hamner, K. C. and Maynard, L. A., 1942, Factors influencing the nutritive value of the tomato. A review of the literature, *U.S.D.A. Misc. Publ.*, **502,** 23pp.
9. Hansen, E., and Waldo, G. F., 1944, Ascorbic acid content of small fruits in relation to genetic and environmental factors, *Food Res.*, **9,** 453-61; *C.A.*, **39,** 1898.
10. Harding, P. L. and Thomas, E. E., 1942, Relation of ascorbic acid concentration in juice of Florida grapefruit to variety, root-stock and position of fruit on the tree, *Jour. Agric. Res.*, **64,** 57-61.
11. Loeffler, H. J. and Ponting, J. D., 1942, Ascorbic acid. Rapid determination in fresh, frozen, or dehydrated fruits and vegetables, *Ind. Eng. Chem. An. Ed.*, **14,** 846.
12. Mapson, L. W. and Cruickshank, E. M., 1947, Effect of various salts on the synthesis of ascorbic acid and carotene in cress seedlings, *Biochem. Jour.*, **41,** 197.
13. McCollum, J. P., 1944, Some factors affecting the ascorbic acid content of tomatoes, *Amer. Soc. Hort. Sci. Proc.*, **45,** 382.
14. Mendel, K., 1952, The influence of environment and rootstock on the maturation of citrus fruits. (In preparation).

15. Mentzer, C. and Fatianoff, O., 1949, Influence des méthodes culturales sur la teneur en vitamines des végétaux supérieurs, *Annales de la nutrition et de l'alimentation*, **3**, 645.
16. Monselise, S. P., 1950, Ecological conditions in the grove, and the assimilation of carbon by citrus trees, *Doctorate thesis*, *The Hebrew University of Jerusalem*, 206 pp.
17. Reid, M. E., 1942, Effect of variations in light intensity, length of photoperiod and availability of nitrogen upon accumulation of ascorbic acid in cowpea plants. *Bull. Torrey Bot. Club*, **69**, 204.
18. Robinson, W. B., 1949, Effect of sunlight upon ascorbic acid content of strawberries. *Jour. Agric. Res.*, **78**, 257.
19. Rubin, B. A. and Spiridonova, N. S., 1940, Vitamin C and the oxidation capacity of plant tissues, *Biokhimiya*, **5**, 208-16; *C.A.*, **34**, 1711.
20. Samisch, Z. and Cohen, A., 1949, Composition of oranges in Israel, *Agric. Res. Sta. Rehovot Bull.*, **51**, 46 pp.
21. Shamel, A. D. and Pomeroy, C. S., 1934, Relation of amount of foliage to fruit size in Valencia oranges, *Calif. Citrogr.*, **19**, 140.
22. Sites, J. W. and Reitz, H. J., 1950, The variation in individual Valencia oranges from different locations on the tree as a guide to sampling methods and spotpicking for quality. Part III. Vitamin C and juice content of the fruit, *Amer. Soc. Hort. Sci. Proc.*, **56**, 103.
23. Smith, M. C. and Caldwell, E., 1944, Variations in the ascorbic acid content of Arizona oranges, *Agr. Exp. Sta. Arizona Mim. Rep.*, 685 pp.
24. Somers, G. F., Kelly, W. C. and Hamner, K. C., 1948, Changes in ascorbic acid content of turnip-leaf discs as influenced by light, temperature, and carbon dioxide concentration, *Arch. Biochem.*, **18**, 59.
25. Somers, G. F. and Beeson, K. C., 1948, The influence of climate and fertilizer practices upon the vitamin and mineral content of vegetables, *Adv. in Food Res.*, **1**, 291.
26. Turrell, F. M. and Klotz, L. J., 1940, Density of stomata and oil glands and incidence of waterspot in the rind of Washington Navel orange, *Bot. Gaz.*, **101**, 862.
27. Watanabe, K., 1938, Vitamin C in pineapple fruits, *Jour. Soc. Trop. Agric., Taihoku Imp. Univ.*, **10**, 67-75; *C.A.*, **33**, 5027.
28. Webber, H. J., 1943, *The citrus industry I. History, botany and breeding*, Univ. Calif. Press, Berkeley, 1028 pp.
29. Willimott, S. G., and Wokes, F., 1926, Oxidizing enzymes in the peel of citrus fruits, *Biochem. Jour.*, **20**, 1008.
30. Winston, J. R., and Miller, E. V., 1948, Vitamin C content and juice quality of exposed and shaded citrus fruits, *Food Res.*, **13**, 456.
31. Wokes, F. and Melville, R., 1948, Vitamin C in the walnut *Juglans regia*, *Biochem. Jour.*, **43**, 585.

ON THE UPPER CRETACEOUS AND TERTIARY STRATIGRAPHY OF A BORING NEAR BETH-GOVRIN (ISRAEL)

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INTRODUCTION

The present paper deals with a 404 m deep boring at Gal-On village, nearly 50 km S of Tel-Aviv and approximately 4 km NW of Beth-Govrin (Beth Jibrin).

The region presents part of a big syncline which, beginning East of Lydda, in the Ayalon valley, and continuing in a SSW direction, develops into a broad synclinorium, flanked in the East by the Hebron Hills (Hebron anticline) and descending towards the West in broad undulations, almost concealed by thick Eocene sediments; still farther to the West the structure disappears entirely under thick, practically horizontal layers of Neogene and Pleistocene deposits.

The boring point is situated probably near the midst of the axial zone of this syncline at 185 m above sea level. Because of this situation, and being the deepest boring in the region, its examination was of considerable interest and the determination of its stratigraphical sequence of great importance for further investigations in the whole region.

The available boring-samples (Rotary-cuttings) were rather small ones, somewhat limiting the possibilities of study. Furthermore, several portions of the boring have been drilled without taking samples and, therefore, it was not always possible to determine the stratigraphical boundaries with certainty. The results obtained from the examination of the boring-samples were compared, as far as possible, with observations on outcrops in the region.

The foraminiferal fauna has been examined and determined by the junior author.

Each drilled strata-complex, from which a continuous series of samples was available, has been designated in the text and in the attached table by letters, from A to L.

STRATIGRAPHY

The uppermost layer (~ 1 m thick), represented by young, unconsolidated material, has not been sampled. Below it, the following stratigraphical units have been recognized: Neogene, Eocene, Danian-Paleocene, and Upper Cretaceous (Maestrichtian to probably Campanian). Oligocene, although it occurs in the area, has not been disclosed in this boring.

Neogene (*A*)

Lithologically, the Neogene,~ 3.5 m thick, is represented by a hard, yellow to pink, conglomeratic limestone with few and badly preserved foraminifera. The forms recognized are: *Elphidium* cf. *E. crispum* (Lin.), *Asterigerina planorbis* (d'Orb.), *Rotalia* (*Streblus*) *beccarii* (Lin.), *Bulimina* sp., *Miliolidae* sp.

Received January 5, 1953

This assemblage points to the Neogene, without indicating, however, a more exact position. In comparison with several surface formations of the same lithological and faunistic character, cropping out in the area, Pliocene is to be assumed.

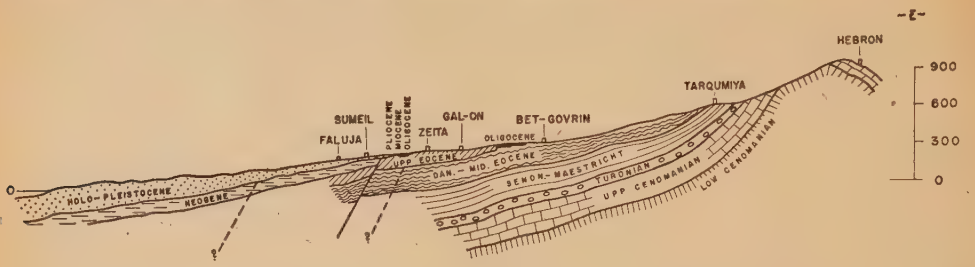


Figure 1
General cross-section showing the structure and stratigraphical sequence.

Several Neogene outcrops and subsurface occurrences of different character are known in this region: 2 km SW of Gat (~6 km W of Gal-On) there occurs a small relic of reddish-yellow, crystalline, sandy limestone of reef-character. By its lithological and faunistic characters it is comparable with Middle Miocene coral-reef formations in the Shephelah region (Coastal Plain) and some other places in Israel. The relics near Gat are rich in *Amphistegina* and *Neoalveolina* ("*Borelis*") as well as in Astraeidae-corals and *Millepora*, and therefore a lower Vindobonian (Helvetian) age should be assumed.

Some 3—4 km W of Gal-On, in Wadi Zeita, a boring has revealed, at a depth of 24—43 m, a yellowish limestone, rich in *Amphistegina*. This limestone, too, is doubtless of Miocene age. In the vicinity of this boring there occur on the surface patches of Pliocene calcareous sandstone, yellowish-pink in colour and mostly conglomeratic.

The Pliocene formations are clearly separated from the Miocene ones by a stratigraphical gap and they are paleogeographically independent. The Miocene itself reposes unconformably upon Oligocene or upon different parts of the Eocene. The Pliocene is rarely found lying upon the small relics of Miocene or Oligocene age, left by abrasive actions; it is mostly reposing upon Eocene.

Oligocene, although not encountered in the boring at Gal-On, is quite characteristic in this region, being dispersed there in relatively big relic-patches. It occurs some 2.5 km W of the boring-point at Zeita. These Oligocene deposits were previously described by the senior author (Avnimelech 1936, 1939, 1943). According to his conclusions, Oligocene rocks are reposing with strong erosional discordance on Eocene. Hard, sandy *Operculina*-limestones of Stampian age are well characterized by *Nummulites* (*N. bouillei*, *N. tournoueri*) and by *Lepidocyclina* (*L.* (*Eulepidina*) *dilatata*, *L.* (*Nephrolepidina*) *tournoueri*, etc.). Higher up, there follows a marly formation, belonging to the Aquitanian.

Eocene (*B—G*)

The samples of the portion B, which is ~11 m thick, are represented lithologically by a fine grained, glauconitic, detritic, chalky limestone, whitish-grey in colour and partly limonitic. The samples of the lowermost layers of this portion are somewhat phosphatic. From the foraminifera, which are in part limonitized, several species of *Bolivina*,

Siphonodosaria, *Bulimina*, *Uvigerina*, *Eponides*, *Gyroidina*, *Cibicides*, *Globigerina*, etc. are noticeable together with the following important forms: *Globigerinella*? *micra* (Cole), *Globigerinoides index* Finlay, *Hantkenina alabamensis* Cushman, *Globorotalia cerro-azulensis* (Cole), *Globorotalia centralis* Cushman and Bermudez, *Cibicides cushmani* Nuttall. Fish-remains are noticeable and in the lower part of B, numerous *Radiolaria* are present.

The following sampled portion C is ~2.5 m thick. Lithologically the samples from this portion do not differ from those of B and the faunal composition is generally the same.

Considering the occurrence of the foraminifera mentioned above, the strata complex, comprising the portions B and C, is determined as of Upper Eocene age.

An Upper Eocene age, based on the occurrence of *Aturia rovasendiana* Parona, was admitted (Avnimelech 1943) for a limestone formation occurring in a quarry at Araq el Kharab, a locality some 6 km SW of the boring-point. Possibly this formation corresponds to the complex B-C of the boring.

The next drilled portion, ~70 m thick (D), from which samples were available, is composed in its upper part of a whitish-grey chalky limestone, somewhat limonitic, more compact at its base and containing tiny concretions of limonite. Below, there is a grey partly silicified limestone; the silicification gradually increases downwards from ~120 m depth. Limonite occurs occasionally and from about 125 m depth is partly replaced by pyrite, which forms small aggregates at ~145 m depth. The degree of silicification decreases in the basal layers of D.

A partly silicified, but a little marly, limestone makes up the portion E, about 9 m thick. It contains pyrite and is much less siliceous, the silicification being almost absent in the basal part of this portion.

The foraminiferal fauna of both D and E is chiefly composed of *Globigerina* and *Globorotalia*, to which various species of *Uvigerina*, *Bulimina*, *Cassidulina*, *Eponides*, *Cibicides*, etc. should be added. The state of preservation of the foraminifera is generally bad, making the identification difficult. The following forms were recognized: *Bifarina nuttalli* Cushman and Siegfus, *Bulimina tarda* Parker and Bermudez, *Eponides umbonata* (Reuss), *Eponides trümpyi* Nuttall, *Cibicides cushmani* Nuttall, *Cibicides pseudoconoidea* Cita, *Globigerinella*? *micra* (Cole), *Globigerina* cf. *G. linaperta* Finally, *Globorotalia aragonensis* Nuttall, *Globorotalia wilcoxensis* Cushman and Ponton, *Globorotalia* ex. gr. *G. crassata* (Cushman), *Hantkenina dumblei* Weinzierl and Applin, and *Globigerinoides* gr. of *G. orbiformis* (Cole)-*mexicana* (Cushman). The *Radiolaria* occur abundantly.

The next sampled portion F is ~21 m thick. Its upper part is composed of a white-greyish, marly chalk with limonite and pyrite, becoming detritic in its lower portion. There follows portion G (~16 m. thick), composed in its upper part of a fine grained, calcareous marl, which becomes somewhat glauconitic and pyritic below.

The microfauna of both portions F and G is again very rich in *Globigerina* and *Globorotalia* and contains among others: *Bulimina tarda* Parker and Bermudez, *Eponides umbonata* (Reuss), *Eponides trümpyi* Nuttall, *Alabamina wilcoxensis* Toulmin, *Cibicides cushmani* Nuttall, *Cibicides pseudoconoidea* Cita, *Globigerinella*? *micra* (Cole), *Globigerina triloculinoides* Plummer, *Globorotalia wilcoxensis* Cushman and Ponton, *Globorotalia aragonensis* Nuttall, *Globorotalia simulatilis* (Schwager). The Radiolaria are abundant and fish-remains occur.

The strata-complex comprising portions D, E, F, and G is interpreted as Lower and Middle Eocene. The available material is not sufficient to make a more exact subdivision. For the same reason it is not possible to draw any conclusions with regard to a possible discontinuity between the Middle and Upper Eocene. Such a discontinuity, clearly marked — from the faunistic and structural points of view, — has been observed by the senior author in the region of the Megiddo syncline SE of the Carmel Mountains (Avnimelech 1943).

In conclusion the Eocene revealed in the boring at Gal-On has an approximate thickness of 250 m.

Danian-Paleocene (*H*)

This strata-complex, about 50 m thick, is composed in its upper part of a grey, marly, slightly phosphatic chalk, becoming downwards granular and glauconitic. Lower down the complex is represented by a grey, calcareous shale, very finely glauconitic, becoming less sticky at about 285 m depth and somewhat detritic and slightly phosphatic at ~290 m. Chemical analysis revealed traces of bitumen. Down to a depth of 308 m there occurs much pyrite, probably the main cause for the grey colour of this shale. Limonite is occasionally encountered. From the microfaunistic point of view, the upper part of the portion H is characterized mainly by the abundance of *Globigerina* and *Globorotalia*, to which rather frequent Discorbidae should be added, whilst the lower shows an abundance of *Globigerina* and Discorbidae. Recognized forms are: *Spiroplectammina* cf. *S. carinata* (d'Orb.), *Neoflabellina jarvisi* (Cushman), *Bolivina midwayensis* Cushman, *Loxostomum applinae* (Plummer), *Bolivinoides decorata delicatula* Cushman, *Allomorphina conica* Cushman and Todd, *Quadrimorphina allomorphinoides* (Reuss), *Eponides trümpyi* Nuttall, *Eponides umbonata* (Reuss), *Pseudovalvulineria* sp. (see Reiss 1952), *Pseudovalvulineria avnimelechi* Reiss, *Alabamina wilcoxensis* Toulmin, *Alabamina midwayensis* Brotzen, *Osangularia lens* Brotzen, *Cibicides beaumontiana* (d'Orb.), *Anomalina pseudoacuta* Nakkady, *Anomalinoides danica* (Brotzen), *Anomalinoides vanbelleni* ten Dam and Sigal, *Globigerina triloculinoides* Plummer, *Globigerina pseudobulloides* Plummer, *Globigerina compressa* Plummer, *Globorotalia simulatilis* (Schwager), *Globorotalia membranacea* (Ehrenberg) (Cushman), *Globorotalia velascoensis* (Cushman). Rare fish-remains are noticeable.

This faunal assemblage points clearly to the Danian-Paleocene age of the portion H.

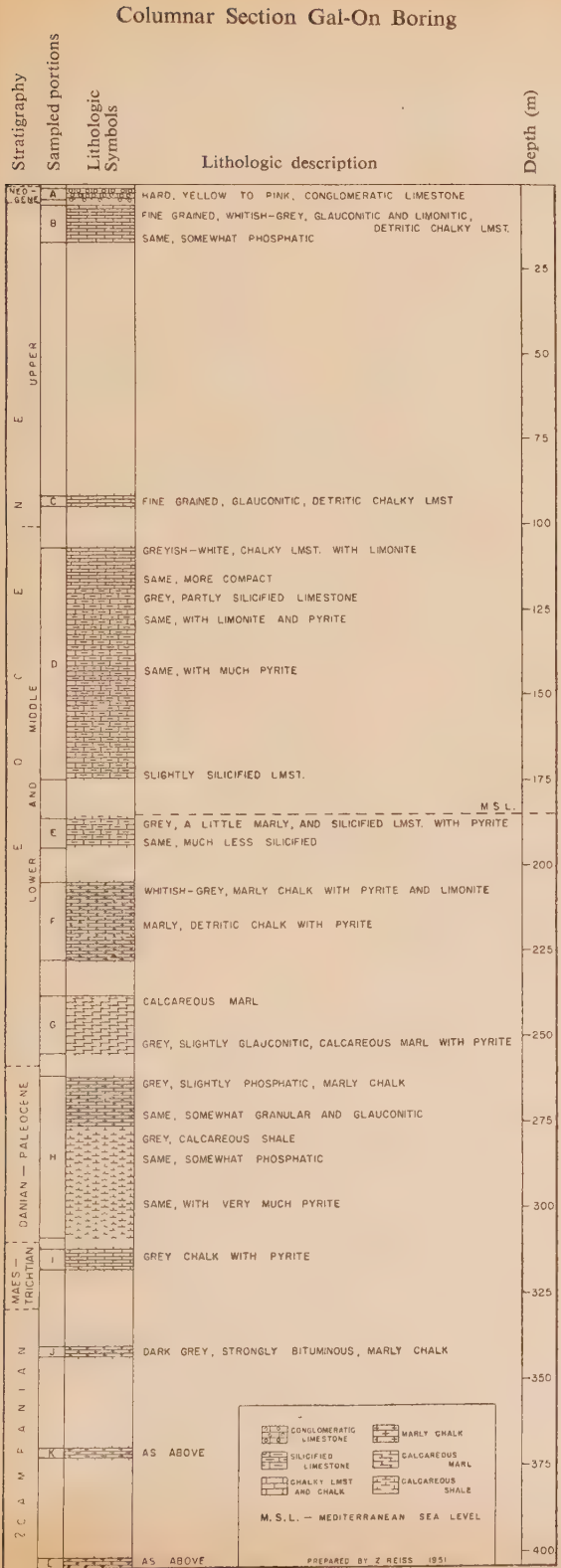
Upper Cretaceous (*I—L*)

Only a few samples were available from the strata belonging to the Upper Cretaceous disclosed in the boring at Gal-On.

The most characteristic, from the microfaunistic point of view, is the sampled portion I, composed of a fine-grained, pyritic, grey chalk.

The fauna is characterized mainly by the abundance of large and ornamented *Gümbelina* and *Pseudotextularia*, as well as by rather frequent Discorbidae and Bolivininae. The *Globotruncana* and *Globigerina* occur in moderate quantities.

More important forms are: *Bolivina incrassata* Reuss, *Bolivinoides draco draco* (Marsson), *Bulimina kickapooensis* Cole, *Buliminella laevis* (Beissel), *Pseudouvigerina cristata* (Marsson), *Quadrimorphina allomorphinoides* (Reuss), *Pseudovalvulineria* sp., *Stensiöina pommerana* Brotzen, *Cibicides voltziana* (d'Orb.), *Cibicides beaumontiana* (d'Orb.),



Cibicides abudurbensis Nakkady, *Gümbelina excolata* Cushman, *Pseudotextularia elegans* Rzehak, *Globigerina rugosa* Plummer, *Globotruncana cretacea* Cushman, *Globotruncana conica* White, *Globorotalites* sp.

The faunal assemblage points to the Maestrichtian age of the portion I.

The following sampled portions, J, K, and L, are represented by a dark grey, strongly bituminous, marly chalk, with a microfauna poor in species and specimens and composed mainly of *Lagenidae* and specimens of *Gyroidina*, to which a few specimens of *Cibicides* sp., *Globotruncana arca* (Cushman), *Globotruncana fornicata* Plummer, *Globigerinella aspera* (Ehrenberg), *Gümbelina globulosa* (Ehrb.), *Neoflabellina* ex. gr. *rugosa* (d'Orb.), *Nodosaria*, *Lenticulina*, etc. should be added. Definite, positive proof as to the exact age of these strata is lacking. By comparison with other subsurface formations of Campanian age of our country, as well as taking into account the lack of any form characteristic for the Maestrichtian, the strata complex comprising J—L is considered to be probably of Campanian age.

In conclusion, the Upper Cretaceous strata, disclosed in the boring at Gal-On, with a total thickness of nearly 100 m, are of Maestrichtian and probably Upper Campanian age.

Drilling stopped at a depth of 403.80 m without reaching the base of the Senonian.

SUMMARY AND CONCLUSIONS

Based on the analysis of foraminiferal faunas and supported by lithological evidence, the strata disclosed in the boring at Gal-On can be subdivided into the following stratigraphical units: Recent to Upper Neogene, approx. thickness 5 m; Upper Eocene, approx. thickness 95 m; Lower and Middle Eocene, approx. thickness 155 m; Danian-Paleocene, approx. thickness 50 m; Maestrichtian and top of ?Campanian, approx. thickness 98 m.

The thickness as well as the facies-characters of the strata revealed by the boring at Gal-On, clearly support the structural interpretation of the region, as it results from field observations. The sedimentation during Upper Cretaceous and Lower Paleogene times has taken place in a gradually subsiding broad synclinal area. The syncline was already in the making at the beginning of Upper Cretaceous times. Subsidence and folding slowed down markedly during Eocene times; the folds have been gradually smoothed, although the undulations were still pronounced enough even in the Upper Eocene. The strong erosional and structural discordance between the Middle and Upper Eocene in the Megiddo region (SE of the Carmel Mountains) shows that the folding during these times has caused the uplifting of important parts of the country above the sea-level, with several depositional basins of pelagic character — like that of Beth Govrin — still remaining. The Oligocene Sea could penetrate into narrow synclinal passages, while the Miocene transgression was rather controlled by the beginning of younger tafrogenetic movements, connected with the decisive development of Palestinian parts of the great Rift-Valleys.

Since the Beth Govrin syncline appears to be broadly and gently undulated, it is to be supposed that the Senonian strata-complex will not be exceedingly thick and that, for instance, in the Gal-On boring the base of the Senonian could be reached at a depth of some 500—600 m. It is also to be presumed that nearer to the flanks of the Hebron anticline, at a small distance east of Beth Govrin, the Senonian to Eocene strata-complex will be thinner than at Gal-On and that water, supplied by Turonian rocks, could be reached there at a depth of some 400 m.

REFERENCES

1. Avnimelech, M., 1936, *Etudes géologiques dans la région de la Shéphéla en Palestine*, Grenoble.
2. Avnimelech, M., 1939, On the Geology and Morphology of the Megiddo Area, *Journ. Palestine Orient. Soc.*, **19**, 18.
3. Avnimelech, M., 1943, Transgressive Upper Eocene in Palestine, *Geol. Magaz.*, **80**, 107.
4. Avnimelech, M., 1943, Lower Tertiary Aturia from Palestine, *Journ. Paleontology*, **17**, 115.
5. Picard, L. and Solomonica, P., 1936, On the Geology of the Gaza-Beersheba District, *Journ. Palestine Orient. Soc.*, **16**, 255.
6. Picard, L. and Avnimelech, M., 1937, On the Geology of the Central Coastal Plain, *Journ. Palestine Orient. Soc.*, **17**, 255.
7. Reiss, Z., 1952, On the Upper Cretaceous and Lower Tertiary Microfaunas of Israel, *Bull. Res. Counc. of Israel*, **2**, 37.

POSSIBLE ORIGINS OF MANGANESE ORE IN THE NEGEV

E. STURM
Geological Survey of Israel

INTRODUCTION

The work on which this paper is based was carried out with many long interruptions between March and December, 1951. The purpose of the work was to explore the manganese deposit in Wadi Menayeh in order to obtain estimates of its extent, its reserves, and data on the nature and concentration of the ore. With this aim in mind, a great number of outcrops was carefully examined, samples were megascopically and chemically analyzed, a topographic and geologic map of the area containing manganese-rich outcrops was prepared, several channel samples were taken, and two exploratory tunnels were driven into the deposit. The work was carried out in association with Mahtsavei Israel, who were responsible for the administrative side, such as the maintenance of a base camp, provision of transportation, mining operations, guarding, etc.

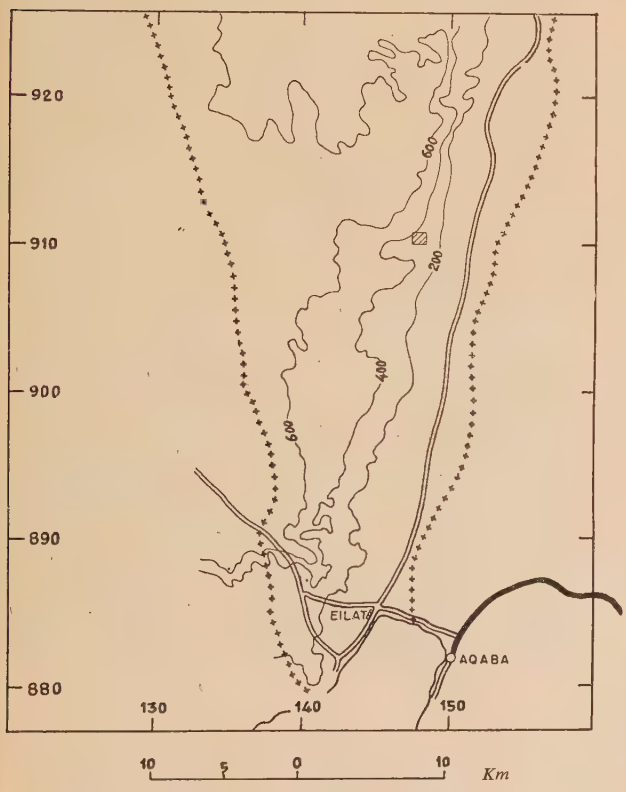


Figure 1 The Southern Negev

An early attempt to explore the deposit is evidenced by the ruin of an old stone house in Wadi Atshane which is said to have been occupied by the first European prospectors. General surveys of the entire area were carried out by government geologists (Blake 1936, Shaw 1947). Mr. Williams, a prospector of long standing in the Negev, is supposed to have explored the deposit. During the years 1945—47, Dr. A. Loehnberg carried out a survey of the deposit under an exclusive government exploration permit.* Many of the sampling pits and trenches dug at that time were sampled during our work. Professor L. Picard in his *Structure and Evolution of Palestine* and his *Geomorphogeny of Israel* deals

Received November 11, 1952.

* Personal communication


MAP OF MANGANESE HILL
MANGANESE HILL
(Central area unmapped)
WADI MENAYEH
WADI MENAYEH
BARAKH
ATSHANE
HILL OF THE CAVE
TOPOGRAPHY:
A. REICH, P. STRAUSS, E.A. STURM
GEOLOGY:
E.A. STURM
LOWER MARICOLITED SANDSTONE
CARBONIFEROUS
FAULT
CONTACT, ASSUMED, APPROXIMATE
SAMPLING SITE
DIVISION OF RESPONSIBILITY FOR TOPOGRAPHY
STURM
GRADER
REICH
DRAWING BY: BLUMENFELD
MAGNETIC DECLINATION 4°32' EAST OF TRUE NORTH (1952) ANNUAL CHANGE: 0.5' EAST
9000
9500
10000
10500
11000

Figure 2

with the structural aspects of the region. Immediately after the War of Liberation, Dr. Y. Bentor and Dr. Vroman mapped the geology of the area under the auspices of the Army. The former also made a reconnaissance survey of Wadi Menayeh for the Palestine Mining Syndicate in 1936 and in 1942.

METHODS OF WORK

Field Work

Work in the field began with the usual reconnaissance trips. Geological surface features were inspected, and particular attention was paid to the numerous outcrops of manganese ore. The topography and geology of the area likely to contain the richest manganese ore were mapped on a 1:5,000 scale. The map was prepared by the plane table method, using a small Gurley alidade. In order to save time and effort, only the topography above and below the deposit was mapped. A topographic map of part of the area, previously prepared by an independent surveyor, was incorporated into the map (Figure 2). The sites for two experimental tunnels were selected and their directions determined. 14 sampling sites scattered around "Manganese Hill" and two sites on "Hill of the Cave" were chosen and surveyed. Large channel samples were obtained with the help of pneumatic hammers. At each completed site, a vertical channel sample of an average length of 3 to 4 metres was taken.

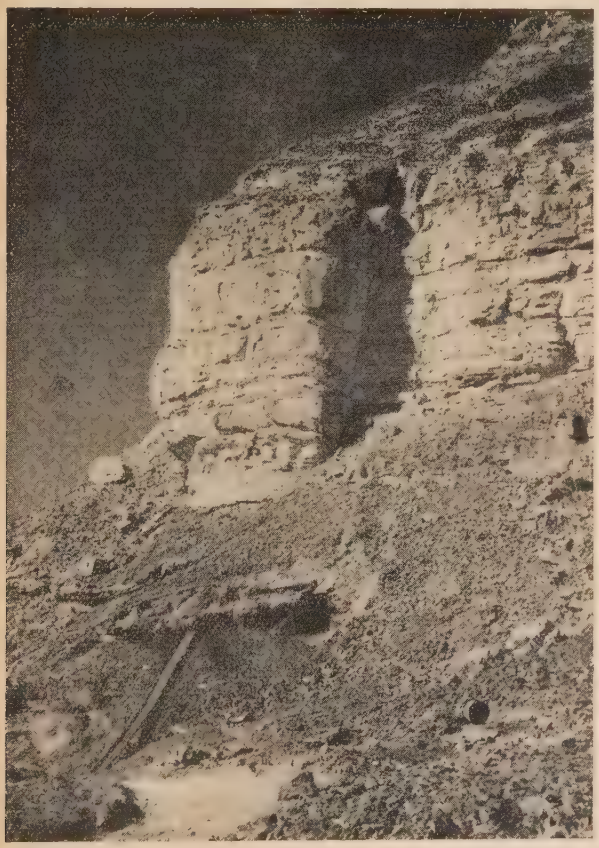


Figure 3
Tunnel No. 7

Laboratory and office work

An ordinary megascopic examination was carried out on all specimens collected in the field. In order to arrive at a proper classification of the highly variable rocks containing the ore, the specimens of one channel sample were mechanically analyzed, and on the basis of the results obtained the rocks were classified. Mechanical analysis consisted of the physical disintegration of the rock, the removal of the "fines" (<.044 mm) by decantation, division

Figure 4
View across Wadi Barakh

into seven size fractions by Tyler Standard Screens, the weighing of the different fractions, and the statistical representation of the results. Sizes too fine for the screens were separated by the differential settling method.

GEOGRAPHY AND GEOLOGY OF THE MANGANESE DEPOSIT

The name Wadi Menayeh, now Nahal Timna, is applied to a large erosion cirque open to the east, with a radius of about 3 to 4 km, which is located west of the Araba and whose centre is about 25.5 km north of Elath. Wadi Menayeh embraces three distinct wadis, Wadi Barakh (Nahal Timna Tsefoni) is the northern, Wadi Atshane (Nahal Timna Merkasi), the central, and Wadi Um Ghaddak (Nahal Timna Deromi) the southern member of the group. The walls of the cirque, which reach a height of about 250 m, are formed largely by "Upper Variegated Sandstone" of Lower Cretaceous and by dolomites, marls, and limestones of Cenomanian age. Isolated hills within the cirque comprise White Sandstone (Jurassic?), Lower Variegated Sandstone (Permian or Triassic?), "Carboniferous" sandstone, shales, limestones, and dolomites, Paleozoic Nubian Sandstone, consisting of arkosic sandstone, and finally the base complex of granites, syenites, rhyolites, and basic intrusives. The base complex is exposed at the core of the erosion cirque, forming a hill about 4 km long and 3 km wide and reaching a height of about 250 m.* Manganese occurs just below the contact of the "Carboniferous" and the overlying Lower Variegated Sandstone. The almost complete lack of fossils makes the direct determination of the age of these

* The terminology of the different stratigraphic units, used in this paper, is that established by Dr. Bentor (personal communications).

Figure 5

Red sandstone

Base of Lower Variegated Sandstone
Top of "Carboniferous" formation

Red and green clay, containing large and small manganese concretions

Well-bedded tan, buff and green shale, containing spots of copper.

Salty in joints and bedding planes containing no manganese.

Dark gray sandy shale

Varved sandstone ("Zebra Sandstone").

Well-bedded manganiferous sandstone.

Correction in cliché:
130 *should read* 1.30
1-250 *should read* 1-2.50

rocks impossible. However, a few badly preserved fossils and the similarity of the deposit to the one at Um Bogma, Egypt (Ball 1916), for which Carboniferous age has been definitely established, may possibly justify the dating of the deposit as Carboniferous too. The term "Carboniferous" is here employed with reservation; the writer is using it as a non-committal name rather than as an indication of age. The "Carboniferous" formation, which is 18 m thick in Wadi Um Ghaddak, is underlain by the Paleozoic Nubian Sandstone. The contact of the two formations seems to be conformable. The lower part of the "Carboniferous" is highly variegated, consisting of sandstones, shales, thin beds of dolomites or limestone, and thin beds of conglomerates. The upper part of the "Carboniferous" is usually a grey or pink dolomite or limestone or sandstone. In the opinion of the writer, the sandstone locally found instead of the dolomite could have been calcareous and subsequently leached. The uppermost layers of the "Carboniferous" contain most of the manganese. The lowest member of this group is a well-bedded, sometimes clearly varved sandstone (Figure 10). The thickness of this member is variable, owing to its irregular lower contact; it ranges from about 1 to 4 metres. It is overlain by usually undisturbed tan, red, and green shales. In their bedding planes very small amounts of copper in the form of isolated green spots can be found. These shales contain no manganese. They in turn are overlain by 1 to 2 metres of mainly red shale which shows a great deal of distortion. The major portion of the ore is concentrated in this disturbed zone, which forms the uppermost layer of the "Carboniferous" formation (Figure 5 and Figure 10). The contact of the "Carboniferous" formation and the Lower Variegated Sandstone is not conformable, as it appears to be in outcrops. On the basis of data from drill holes in Wadi Atshane, an unconformity of as much as 7° was found to exist between the two formations. The lower portion of the overlying Lower Variegated Sandstone is locally fractured. This sandstone consists largely of red and pink, medium-grained sandstone. With the exception of small, economically unimportant fracture fillings, no manganese is found in these layers.

DESCRIPTION OF THE ORE

In the region under consideration, manganese occurs in the following forms:

1. Concretions of manganese dioxide (nodules of pyrolusite).
2. Bedded or finely disseminated manganese dioxide.
3. Recent accumulations of the manganese-rich sand.
4. Pyrolusite crystals in the manganese-rich sand.
5. Dike-like structures.
6. Irregular spots in limestone or dolomite.
7. Small veinlets or crack-fillings in layers adjacent to ore bearing strata.

The ore in the upper part of the enriched zone is usually *concretionary*. Figure 5 and Figure 10 show typical sections through the ore-bearing layers. The concretions, whose diameters range in size from smaller than 1 mm to about 30 cm, are concentrated in the red, and in places green, clay, forming a layer of about 1 to 2 metres (disturbed zone). The concretions are often lined up in discontinuous bands. MnO_2 content of the concretions was found to range from about 28% to about 64%. Most of the ore appears to be powdered or fine-crystalline pyrolusite.

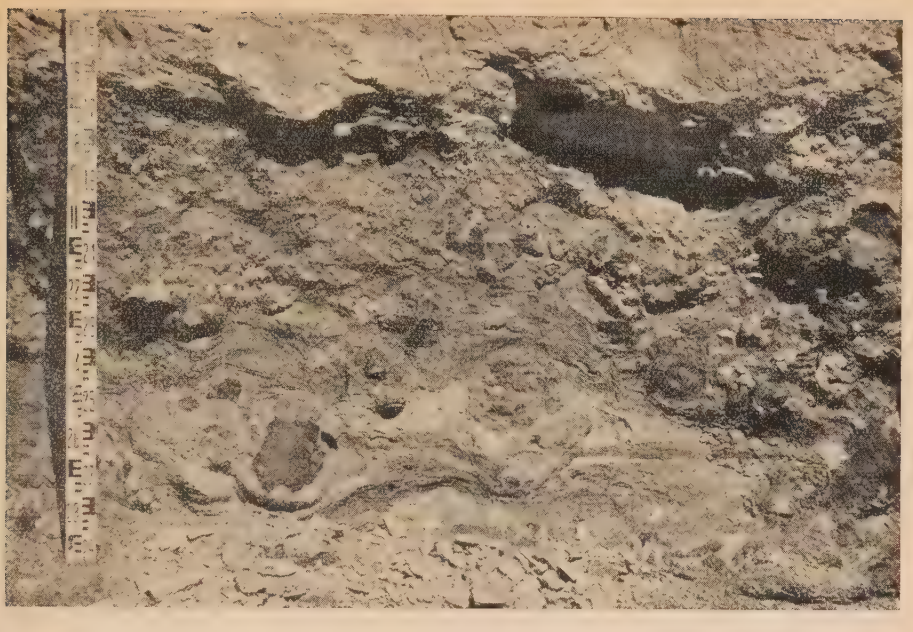


Figure 6
Zone of concretionary ore immediately below the contact of the "Carboniferous" and Lower Variegated Sandstone. West of the entrance to Tunnel No. 8, Wadi Atshane

Disseminated MnO_2 occurs in well-defined layers. Some outcrops show this type of ore in fine-grained sandstone within the red clay zone in which the concretionary ore is usually found. Commonly, the disseminated ore is found below the green and buff coloured clay beds, in the grey, medium- to fine-grained sandstone and siltstone. In some places, the manganese-rich layers are found to alternate with manganese-poor layers, forming fine, well-defined black and light gray or buff varves. A specimen of the varved sandstone (also called "Zebra Sandstone") was analyzed for its manganese content, and a mechanical analysis was carried out on the same sample. The results of the analyses appear in Table I. It seems safe to assume that the disseminated ore consists almost entirely of powdery manganese dioxide (pyrolusite).

Ore diffused in sharply defined layers or beds is usually found in non- or slightly disturbed beds. In some outcrops, it may be found below the concretionary ore (see Figure 10); in others it may be found in place of it.

Manganese ore is also found in the form of small *placer deposits* of fine-grained sand adjacent to outcrops of the Upper "Carboniferous". These deposits were most likely formed by a process of selective removal of rock particles and grains. Silt-sized grains with a coating of MnO_2 (and possibly smaller particles consisting entirely of MnO_2) were not as easily removed by the weathering agents as ordinary sand or silt particles, because of the former's higher specific gravity (specific gravity of MnO_2= 4.75). Well-developed authigenic crystals of pyrolusite can often be found in the manganese-rich sand.

PETROGRAPHY OF THE ORE-BEARING ROCKS

The shales enclosing the concretionary ore were not analyzed. They are mainly red shales with possibly small amounts of silt. Shaly beds below the manganese-rich zone are well-bedded and undisturbed. These in turn are underlain by the varved sandstone.

In order to obtain diagnostic data on the occurrence and possible origin of the manganese, particular attention was paid to the varved sandstone. The table below summarizes the results of the chemical and the mechanical analyses carried out on 8 consecutive varves.

TABLE I

Results of chemical and mechanical analyses of varved sandstone

Varve No.	MnO_2	MnO	Combined Sample	Size fractions in % of entire sample (mm) .5—.25	.25—.125	.125—.063	.063—.031	.031—.016	.016—.008
1	4.68	0.19	A=1+3	.33	1.29	50.90	41.55	4.65	0.73
2	1.40	0.10	B=2+4	.12	.44	42.47	49.75	3.88	2.36
3	3.76	1.05							
4	1.58	0.11							
5	4.08	0.19	C=5+7	3.02	18.2	47.50	24.95	4.82	0.79
6	1.53	0.13	D=6+8	.10	1.9	34.90	53.44	4.62	3.64
7	4.36	0.21							
8	0.49	0.14							

The content of MnO_2 in the dark varves is seen to be only slightly larger than that of the light varves. The MnO content fluctuates with the MnO_2 content. This is brought out clearly in Figure 8. For mechanical analysis, disintegrated samples of pairs of

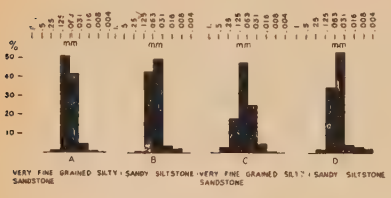


Figure 7

Grain size distribution of combined samples of varved sandstone *samples* A=1+3, B=2+4, C=5+7, D=6+8

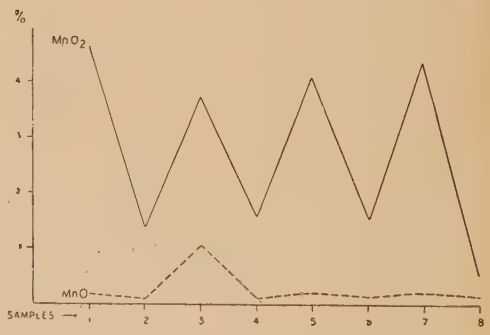


Figure 8

Manganese content of varved sandstone

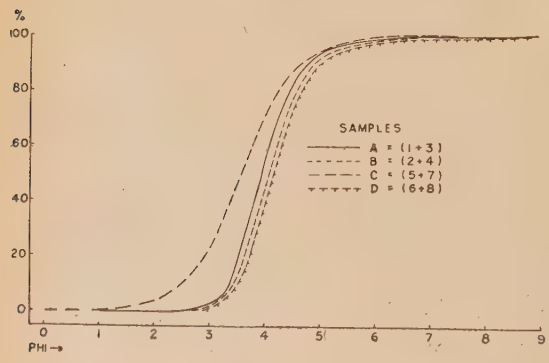


Figure 9

Phi cumulative percentage curves of combined samples of varved sandstone

equally coloured varves were combined. The analysis showed that there is a difference in grain size between the darker and lighter varves. Samples A and C show a concentration of grains in the size fraction larger than .063 mm, while samples B and D (non-manganiferous) show a concentration of grains in the size fraction smaller than 0.63 mm. Thus, manganese appears to be concentrated in the fine-grained sandy layers as opposed to the silty layers.

The size distribution of the grains in the sandy layers is uneven around the modal size, showing a predominance of the fine-grained fraction. On the whole, the grains are well-sorted (Table II). Subrounded quartz grains make up about 80% of the rocks, the remainder consisting largely of dark silt and clay.

TABLE II

Summary of Statistical Measures Carried out on Samples

Sample	First Quartile Phi	Third Quartile Phi	Phi Median	Median (mm)	Phi Quartile Deviation
A	3.60	4.30	3.95	.064	.350
B	3.70	4.95	4.05	.060	.625
C	3.05	4.10	3.60	.082	.525
D	3.80	4.55	4.15	.056	.375

POSSIBLE ORIGINS OF THE ORE

The problem of the origin of the ore may be divided into the following three component problems. (1) Is the deposit sedimentary (syngenetic) or was the ore introduced after the enclosing rock was laid down (epigenetic)? (2) What is the source of the manganese? (3) What was the mode of transportation and deposition of the manganese? Each component problem will be dealt with separately as it applies to the different occurrences of the ore.

Syngenetic versus epigenetic

There is a great deal of evidence supporting a syngenetic origin for the major portion of the ore. The stratigraphic persistence of the manganiferous sandstone and siltstone over a wide area is probably the strongest argument in favour of a sedimentary origin. The manganese ore is not only persistent in regard to its position in the rock column but its minor characteristics and mode of occurrence can also be traced laterally for several kilometres. Another related fact is the uniformity of concentration of the non-concretionary ore in specimens from widely separated locations.

Manganese in the Varved Sandstone. The manganese content of the varves of the "Zebra Sandstone" was found to fluctuate with the texture of the varves (see above). The differences in texture of the varves are possibly due to seasonal fluctuations in which periods of high and low precipitation alternated. It is conceivable that particles of MnO_2 having a specific gravity higher than that of quartz were not carried by the transporting agent (most likely lake or shallow sea currents, as will be pointed out below) during the silt transporting stage, but were picked up and carried by the stronger currents prevalent during the sand transporting stage. Such fluctuations in the power

of the transporting agent are not uncommon. The ore here is clearly syngenetic. If the ore were introduced after the rocks were formed, the manganese content of the varves would not be as persistent horizontally as it is. In the latter case, the invading ore-carrying solutions would prefer easily penetrable channelways, such as bedding planes and joints. Isolated pockets of ore in the manganese-poor varves are also considered syngenetic, as will be pointed out below.

Further details indicating a sedimentary origin are the sharp upper and lower boundaries of these layers and the manganiferous mud flakes (some of them "wrapped around" lumps of medium to coarse-grained non-manganiferous sandstone) and the manganiferous coating on quartz grains which is assumed to be a primary feature because of the impermeable character of the rocks. Furthermore, the fact that manganese is not found disseminated in the more porous Lower Variegated Sandstone may be considered evidence that the deposition of the ore was completed by the time the first layers of this sandstone were laid down.

Manganese concretions. The relative time of origin of the concretions cannot be determined as readily as that of the other ore types. All large concretions are confined to the red shale of the top layer of the "Carboniferous". In many instances it can be seen that the clay was pushed outward and away from the growing concretions (Figure 6). It is possible that the concretions continued to grow, or even began to grow, after the enclosing clay was deposited. The fact that the clay shows no signs of breaking may indicate (a) that the clay was still plastic during the growth of the concretions, or (b) that the clay had hardened but was already deeply buried when growth took place and breakage was prevented by the large confining pressure of the enclosing rocks. Because the concretions themselves do not seem to have been affected by the disturbance evidenced in the crumpled clay beds and broken and jagged blocks of sandstone, it is assumed that they formed or continued to form after the breaking up of the overlying sandstone beds. The possibility that the overlying beds were disturbed and shattered by the growing concretions is considered unlikely because the total displacement could not have been sufficiently large to have caused irregularities of the magnitude observed in many outcrops. Of the two possibilities regarding the plasticity or non-plasticity of the clay during the growing of the concretions, the writer favours the former, since small plications in the layers adjacent to the concretions could not very well have formed in non-plastic clay, no matter how high the confining pressure may have been. If this is true, then the growth of the

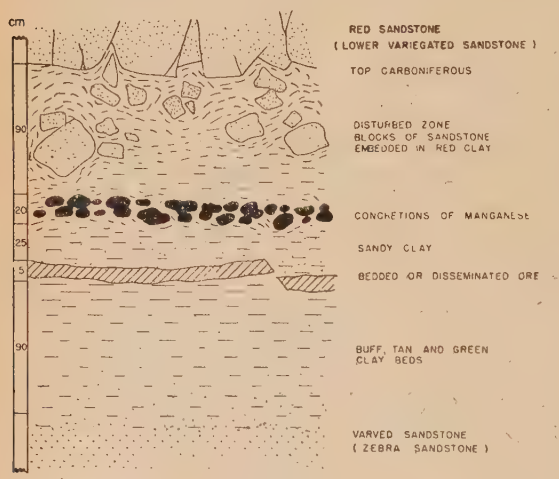


Figure 10
Section East of Tunnel 14 -1 in Wadi Barakh

concretions was not a post-diagenetic process. And, if these interpretations are correct, then at least the outer layers of the concretions were not deposited directly by water surface. During the compaction of the clay into shale, colloidal aggregates may have been deposited around some nuclei, forming small and large concretions. The fact that most concretions are localized in certain beds may indicate that during the formation of these horizons more manganese was deposited than during the deposition of adjacent beds. Small concretions may possibly have existed before the compaction took place. These may later have served as nuclei of large concretions. Accordingly, the concretionary ore may possibly be pre-diagenetic. Another, in the writer's opinion still remoter, possibility is that the beds were disturbed during a period of folding and that the concretions formed or grew at that time. The fact that none of the concretions seen by the writer showed any effects of the displacement caused by minor faults seems to support this possibility. Also, the observation that concretionary ore appears to be more common in highly disturbed zones may possibly indicate that concretions formed best in places where the deformation of the layers forced manganese-bearing solutions to migrate to locations which permitted the growth of concretions. In the latter case, the concretionary ore would be epigenetic. In the writer's opinion, the evidence in support of a syngenetic and pre-diagenetic origin of the concretions is stronger than the one supporting an epigenetic origin.

Small manganese-bearing joints and cracks in the Lower Variegated Sandstone and in the adjacent red shale of the "Carboniferous" are clearly epigenetic. Groundwater or escaping intergranular water of the underlying clay may have been the agent which carried and deposited the ore in the cracks.

Possible sources of manganese

Ruling out the remote possibility of a source rock which was entirely eroded so that we find no trace of it, the manganese must have been derived from the igneous rocks of the region.

The amount of manganese in igneous rocks is small, ranging roughly from .05 to 15% (Twenhofel 1932, p. 562). It could then have become concentrated in a soil overlying the granite complex. The manganese of this soil could then have been leached out by weathering agents and carried to the basin of deposition (sea or lake). Other, still remoter, possibilities are manganiferous bogs, manganese-bearing solutions emanating from hot springs, or sediments very rich in Rhodochrosite, a mangenese-carbonate which weathers to MnO_2. In any case, the large concentration of manganese in the Upper "Carboniferous" is not necessarily entirely due to a large amount of manganese in the ultimate source rock. It is believed that conditions of weathering, deposition, and transportation are factors more decisive in the concentration of manganese than its provenance.

Transportation and deposition

Because of the nature and appearance of the sediments carrying the ore, the following statements can be made with a fair amount of certainty:

1. The manganiferous sandstone and siltstone were deposited in a lake or shallow sea (possibly epeiric).
2. The sediments were deposited under conditions of quiescence.

A shallow sea or lake origin is indicated by the size distribution and sorting of the grains making up the sandstone and siltstone beds. The undisturbed fine bedding seems to indicate that the deposit was not within reach of wave action or strong currents. The regularity of the beds and the lack of cross-bedding as well as graded bedding further support these assumptions. The sediments and the manganese were probably transported by sluggish streams and then evenly distributed in the basin of deposition by slow and relatively weak currents. Particles of fine sand or silt settle very slowly and may easily be carried over wide areas. This may explain the even distribution and consequent regularity of the bedded manganese. The source of the sediments was probably a flat and possibly peneplaned area, cut by a few, slow, widely meandering streams.

Seasonal changes in the carrying capacity of the sediment-supplying streams, as evidenced by the differences in texture of the varves of the varved sandstone, were probably not of prime importance in the transportation of the manganese. However, the supply of manganese provided by the run-off may have been influenced by seasonal changes in precipitation. That is, during the wet season a stronger run-off may have washed more manganese out of the soil and carried it into the streams. Thus, the dark layers of coarser texture and higher manganese-content may represent the rainy seasons. On the other hand, manganese may have been supplied at an even rate throughout the year. Changing biological conditions within the basin of deposition may have influenced the deposition or non-deposition of the manganese. Precipitation of manganese, however, is a process independent of sedimentation; it may have continued at a constant rate during periods of retardation or acceleration of sedimentation. Concentration of manganese in the slightly coarser layers of the varved sandstone may be due to the fact that these layers are more porous than the adjacent finer-grained layers. Figure 7 shows that samples B and D are not only finer-grained than A and C but that their silt and clay content is also larger. An even slightly larger content of the fine-grained components causes significant differences in porosity. This assumption seems to be supported by the fact that MnO_2 found in the manganese-poor varves is not evenly dispersed throughout the rock, as in the manganese-rich varves, but is found concentrated in small pockets. Moreover, in the silty and clayey layers manganese is never dispersed but is found in adjacent coarser-grained lenses or beds or occurs in concretionary masses. MnO_2 may possibly have been transported and come to rest in the basin of deposition in the form of colloidal aggregates. These aggregates may have been larger than the silt and clay particles which enclose them. It is possible that because of the particle size differences, the MnO_2 aggregates were "squeezed" into layers of higher porosity or, where these were missing, came to rest and were deposited on some nucleus, forming manganese concretions.

Above the bedded deposits of clay, in the disturbed zone containing the largest manganese concretions, angular blocks of red sandstone, obviously belonging to the Lower Variegated Sandstone, are found. Large and small mudflakes can be found clinging to the sandstone blocks. In some places black siltstone and silty clay can be found squeezed into cracks in the red sandstone above (Figure 11). It is significant that the blocks of red sandstone embedded in manganiferous siltstone did not absorb manganese to a visible extent. Because the beds below and above show no effects of the intense disturbance, it is assumed that the features of deformation were formed immediately after deposition of the affected beds. In the writer's opinion, the phenomenon of the

Figure 11
Highly distorted manganiferous shale layer. The rocks confining the dark shale consist of slightly displaced blocks of sandstone (Lower Variegated Sandstone). East of sampling site 20

distorted beds can be explained in the following manner. After a certain thickness of Lower Variegated Sandstone had been deposited on the shales of the Upper "Carboniferous", the increasing load of the sandstone finally became too heavy to be supported by the shales which, it is assumed, contained still a large percentage of intergranular water. When the sandstone reached this critical thickness (or weight) its foundation of clay gave under it and the sandstone broke into large and small blocks which sank into the soft mass below. Because of the irregular floor which was thus created, some sandstone blocks came to a temporary rest on the apices of folds of shale beds. Soon they slid, tumbled and rolled down the flanks of these folds, picking up partially hardened manganese mud. This may explain the envelopes of manganiferous mud flakes around some blocks of red sandstone observed in several outcrops. As the sandstone blocks became embedded in the shale they must have displaced great amounts of inter-granular water. The water must have escaped mainly upwards. The escaping water may have carried manganese (in solution, or as colloids, or as suspended fine grained sediment) and deposited it in cracks and joints in the overlying sandstone. This would explain the volumetrically unimportant but interesting deposits

of MnO_2 in joints of the Lower Variegated Sandstone. But the manganese was not carried into the pores of the sandstone. This probably indicates that the sandstone was already well-indurated at the time of the breakup.

SUMMARIZING REMARKS

It is possible to synthesize field evidence, results of laboratory examinations and analyses, and experimental results mentioned in the literature on the subject and in this fashion to picture a hypothetical environment in which the ore may have originated, as well as the conditions of deposition. All deductions made below are of course based on limited evidence and should be accepted with reservation.

When the dolomite and limestone of the Upper "Carboniferous" formation were deposited the place now occupied by Wadi Atshane was comparatively distant from the shore line. Because of an unconformity between the "Carboniferous" and the Lower Variegated Sandstone (about 7° in Wadi Um Ghaddak) and other field evidence it is assumed that there was a discontinuous uplift of the area toward the end of the "Carboniferous." The result of this was a regressive movement of the shore line which began at the time the varved sandstone was deposited on the limestone and dolomite. The source area which supplied the sediments was probably a flat old land mass cut by meandering streams. A deep and possibly manganiferous soil may have covered the land. Because of the predominance of clay materials in the sediments, indicating chemical rather than mechanical weathering, one may assume the climate to have been warm and moist .After the first pulse of the uplift, sand- and fine-sand-sized particles were carried into the lake or shallow sea, which it is assumed formed the basin of deposition. The finest particles were probably carried beyond the zone now occupied by Wadi Atshane. As the land mass was cut down and the sea transgressed on the land again, the litho-facies of "fines" moved toward the Wadi Atshane locality. This is evidenced by the increasingly clayey character of the sandstone above the varved layers (Figure 5). Manganese was carried into the basin during the silt and sand stage. While the tan and green clay was deposited, the run-off may have been too weak to remove appreciable quantities of manganese, thus permitting the manganese to accumulate in the soil. Finally, a stage may have been reached where the concentration of residual manganese in the soil was quite large. Either because of this increase of manganese in the soil or because of another slight uplift of the area, or possibly because of a change in climate toward a greater amount of precipitation, manganese was again transported to the basin. The manganese may have been carried as colloids along with the clay; it was very likely dispersed in the mud of the basin. As the clay become compacted manganese may have been "squeezed" into more porous zones, that is, zones poor in silt and clay, or, by the same process, may have migrated and come to rest on nuclear particles or small MnO_2 concretions, thus increasing the size of the latter. The rate of growth of manganese concretions has been estimated to be of the order of 1 mm in all directions in 1,000 years (Kuenen 1950, p. 382). Assuming uninterrupted growth, a concretion of 25 cm would thus have grown over a period of 125,000 years.

At the end of the period of formation of the "Carboniferous" a general uplift of the land took place. Medium to coarse-grained sand was swept into the basin, and the Lower Variegated Sandstone began to accumulate and lithify. The weight of the overlying

sandstone reached the critical point where the mudstone could not support it. The sandstone broke and blocks of it sank into the still plastic mass of clay. The partially hardened clayey mud was distorted and most of the intergranular water escaped then. During this process, the mud of the "Carboniferous" was converted to shale.

ACKNOWLEDGEMENTS

The writer is indebted to Dr. Bentor, who helped greatly with advice and many stimulating discussions, and to Professor Picard, who helped overcome many difficulties of organization and who read and critically analyzed this paper. Thanks are due to Mr. P. Grader, who introduced the writer to the region; to Engineer M. Miller, whose help and cheerful cooperation made the work a pleasure; to the geologist of Mahtsavei Israel, Mr. Asher Braunfeld, who worked with the writer; to S. Herz, who took all the photographs appearing in this paper; to D. Blumenfeld and S. Levy, who drafted the maps, and to M. Grunberg, who assisted in the laboratory. Finally, thanks are due to the men who held stadia rods, carried sample sacks, drove the cars, and guarded the field party.

REFERENCES

1. Ball, John, 1916, *Geography and Geology of West Central Sinai*, Survey Department, Cairo.
2. Blake, G. S., 1936, *Stratigraphy and Building Stones of Palestine*, Government Printing Press, Jerusalem.
3. Clarke, F. W., 1924, *Data on Geochemistry*, Bull. 770, United States Geological Survey, 437—473.
4. Kuenen, Ph. H., 1950, *Marine Geology*, New York.
5. Picard, L., 1943, *Structure and Evolution of Palestine*, Geology Department, The Hebrew University of Jerusalem.
6. Picard, L., 1951, *Bull. Res. Council of Israel*, **1**, No. 1-2, 5.
7. Shaw, S. H., 1947, *Geological Map of Southern Palestine with Introductory Notes*, Government Printing Press, Jerusalem.
8. Twenhofel, William H., 1932, *Treatise on Sedimentation*, Baltimore, Ohio.
9. Zappfe, Carl, 1931, *Econ. Geol.*, **26**, 799—832.

ANTAGONISTIC ACTION OF *BACILLUS SUBTILIS* AGAINST CITRUS FRUIT PATHOGENS

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In the course of routine isolations of pathogenic fungi from rotten citrus fruits, two instances of antagonism were observed, following bacterial contamination. The two cultures concerned were *Diplodia natalensis* P.E. and *Sclerotium bataticola* Taub., while the contaminant was identified in both cases as *Bacillus subtilis* Cohn emend. Prazmowski*.

Many investigations have been carried out during the last twenty years on the antibiotic properties of *Bacillus subtilis*. Alexopoulos, Arnett and McIntosh (1938), Anwar (1949), Porter (1940), Vasudeva (1930, 1949) and others observed phenomena of antagonism towards various fungi, without having separated the active principle involved. Baron (1950) records some fifteen different antibiotic substances, but most of the information refers only to antibacterial action. A number of substances, such as antibiotic XG (Wallen and Skolko 1950), bacillomycin (Landy, Warren, Rosenman and Colio 1948), eumycin (Johnson and Burdon 1946), mycosubtilin (Walton and Woodruff 1949) and two unnamed agents (Mitchener and Snell 1949) were found to possess antifungal properties. Most of these were investigated from the medicinal point of view and proved to be useful against dermatophytes and systemic fungi (Johnson and Burdon 1946; Landy, Warren, Rosenman and Colio 1948, Walton and Woodruff 1949). Only few tests were performed with plant pathogens (Mitchener and Snell 1949, Wallen and Skolko 1950).

This communication presents a description of several experiments on the antagonistic action of *Bacillus subtilis* in relation to *Diplodia natalensis* and *Sclerotium bataticola* as well as a number of other fungi pathogenic to citrus fruits.

The cultures of *B. subtilis* are designated in subsequent discussion as *B.s.*(D) and *B.s.*(S), according to derivation from cultures of *Diplodia* or *Sclerotium*, respectively.

I. THE ACTION OF *B. SUBTILIS* AGAINST *DIPLODIA* AND *SCLEROTIUM*

Experiment 1

In this experiment *B.s.*(D) was tested for its antagonistic activity towards *Diplodia* (isolate M 1982 in our collection). The two organisms were inoculated oppositely in the same Petri dish containing 2 per cent potato-dextrose agar. It was found several days later that the growth of *Diplodia* was arrested at a distance of approximately 1 cm from the colony of the bacillus (Figure 1). A vacant area, in which no growth of either or-

* The authors are indebted to Dr. Zafrira Volcani of the Agricultural Research Station, Rehovot, for the identification of the contaminant.

Publication of the Agricultural Research Station, Rehovot. 1953 series no. 33.

Received July 10, 1953.

ganism could be detected, separated the two colonies. The periphery of the fungus colony differentiated into several zones. Adjacent to the vacant area, a narrow zone consisting of darker and denser mycelium could be discerned. Further towards the centre of the colony there was a zone of relatively bright and sparse mycelium. This again was followed by a somewhat broader dark area, characterized by proliferous formation of pycnidia. The remainder of the colony had a normal appearance.

Attention should be drawn to the pink colouring of the agar, observed in this experiment. The dye involved is apparently also absorbed by the bacillus, since its colony turns pinkish and later red. The phenomenon of dye production, also described elsewhere (Littauer and Gutter 1953), seems to be brought about by the growth of *Diplodia* under abnormal conditions.

The fact that the growth of the *B. subtilis* colony is relatively slower on the side facing the fungus, indicates that *Diplodia*, in turn, exerts a certain inhibitory influence on the bacillus.

Experiment 2

Cross-inoculations were designed to ascertain whether the antagonistic action displayed by a given isolate of *Bacillus subtilis* is specific to the fungus in association with which it was originally found. Thus colonies of *Sclerotium bataticola* (M 2195) and *Diplodia natalensis* were introduced into separate Petri dishes opposite inoculates of *B.s.*(D) and *B.s.*(S) respectively. This rearrangement did not in any way affect the antagonistic behaviour. The experiment, incidentally, provided a proof that the red colouring substance observed earlier is produced by *Diplodia* and not by the bacillus, since no colouration appeared in the plate sown with *Sclerotium* in association with either of the bacillus strains.

Experiment 3

This experiment, aimed at further elucidation of the antagonistic relationships between *Bacillus subtilis* and the two fungi, consisted of two variants: A. inoculation of the fungi into spore suspensions of the bacillus, B. inoculation of the bacilli into the fungus cultures. In each variant, one half of the plates were inoculated immediately after the agar containing the suspension had set; the inoculation of the remaining plates was made after one day's delay.

In variant A, simultaneous inoculation yielded slight development of *Diplodia* mycelium (about 3 mm in diameter) on the first day, but the growth was subsequently arrested. The confined mycelium assumed a wilted appearance and, upon microscopic examination, revealed balloon-like terminal swellings (Figure 6). *Diplodia* inoculated after a day's delay produced no growth. In the case of *Sclerotium*, no growth could be detected following either form of inoculation.

In variant B, simultaneous introduction of bacilli resulted in inhibition of fungal growth. The hyphal tips of *Sclerotium* became abnormally thickened, club-shaped and ruptured. In the case of *Diplodia*, a vacant belt was observed around the colony of *B. subtilis*, while microscopic examination disclosed the formation of abnormally narrow and misshapen hyphae with balloon-like tips at the periphery of the fungus colony and spores which had failed to germinate. The inhibition was maintained throughout the observation period — approximately three weeks. Delayed inoculation of the bacillus, however, produced no apparent inhibition of fungal growth. On the contrary, *B. subtilis* evidenced weak growth, particularly in association with *Diplodia*.

II. THE INHIBITORY EFFECTS OF *B. SUBTILIS* ON VARIOUS CITRUS PATHOGENS

The action of *Bacillus subtilus* was examined in relation to thirteen different pathogens of citrus fruit. The fungi investigated were: *Alternaria citri*, *Colletotrichum gloeosporioides*, *Diplodia natalensis*, *Fusarium* sp., *Oospora citri-aurantii*, *Penicillium digitatum*, *P. italicum*, *Phomopsis* sp., *Phytophthora citrophthora*, *P. parasitica*, *Sclerotinia sclerotiorum*, *Sphaeropsis* sp. and *Trichoderma viride*. Each fungus was introduced on 2 per cent potato-dextrose agar in the centre of the petri dish, while the two isolates of *B. subtilis* were inoculated peripherally opposite each other. This procedure enabled, in each case, a direct comparison of the antagonistic action of the two isolates. The inocula of the fungi were taken directly from four week old transfers. In the case of *Penicillium digitatum* and *P. italicum*, a spore suspension in water, with the addition of 2 drops of orange juice, served as inoculum. The whole experiment was performed in duplicates. All the plates were incubated at 25 to 27°C.

The various manifestations of antagonistic action have been summarized in Table I. The extent of inhibition has been expressed in terms of width of the vacant zone between the fungus and bacillus colonies (inhibition zone). The measurement was taken at the time of cessation of growth which occurred 2 to 6 days after inoculation, according to the growth rate of the fungus.

The growth of most of the fungus cultures was more or less strongly inhibited by both isolates of *Bacillus subtilis*. The most outstanding inhibition, amounting to total suppression, was observed in the case of *Penicillium digitatum* — one of the most important causal agents of citrus fruit rot.

In most cases, the two isolates of *B. subtilis* did not differ in their antagonistic action; however, with a few organisms, the inhibitory effect of one of the isolates was more pronounced.

The persistency of inhibition during the observation period (three weeks) varied considerably according to species.

Macroscopic changes (Figures 2—5) were largely due to effects on the formation of fruiting bodies and conidia. In some fungi, reproduction was enhanced (e.g. *Diplodia*, *Phomopsis*) while in others it was inhibited (e.g. *Penicillium* spp.). It would seem that *B. subtilis* has a stimulating effect on the reproduction of those fungi which form fruiting bodies, whereas it inhibits reproduction by means of conidia.

Microscopic examination revealed structural changes in all the cultures. Most common are balloon-like swellings of the hyphal tips, frequently accompanied by partial rupture or lysis of the hyphae (Figures 6—10).

The growth of *B. subtilis* was strongly inhibited by *Diplodia natalensis*. A few other species produced slight inhibition of the bacillus.

Crude extracts of *B. subtilis*, prepared by growing the bacillus on potato-dextrose broth, exhibited inhibitory properties similar to those of the cultures. Autoclaving at 15 pounds pressure for 20 minutes did not substantially affect the antibiotic activity of the extracts, which suggests that the antifungal principle is thermostable.

In most instances, the activity of the antibiotic substance concerned appears to be merely fungistatic. However, in a few cases, notably that of *Penicillium digitatum*, the effect is fungicidal, as indicated by the fact that most of the subcultures derived from the inhibited mycelium made no growth.

TABLE I

Manifestations of antagonism between B. subtilis *and* 13 *fungal pathogens of citrus fruits*

Organism	Inhibition effects on fungi					Inhibition effect on *B. subtilis*
	Width of inhibition zone (in mm)	Persistence of inhibition	Mycelium	Fructification and sporulation	Relative effectiveness of bacillus strains	
Alternaria citri	5—10	subsiding	chains of chlamydospore-like structures; swellings; lysis	partially inhibited	*B.s.* (S) > *B.s.* (D)	slight
Colletotrichum gloeosporioides	5—10	transient	balloon-like swellings; lysis	suppressed		slight
Diplodia natalensis	10—15	subsiding	narrow, twisted, with balloon-like swellings	stimulated near inhibition zone	*B.s.* (D) > *B.s.* (S)	marked
Fusarium sp.	0—5	rapidly subsiding	inflated, occasionally ruptured tips	unaffected		slight
Oospora citri-aurantii	10—15	slowly subsiding	prostrate, sparse, ramified; tips occasionally ruptured	partially inhibited		none
Penicillium digitatum	>15	persistent	attenuated, misshapen, with giant cells; inflated, occasionally ruptured tips	completely inhibited		none
Penicillium italicum	10—15	persistent	attenuated, stunted; balloon-like swellings, occasionally ruptured	strongly inhibited		none
Phomopsis sp.	10—15	persistent	misshapen, with small swellings	accelerated		none
Phytophthora citrophthora	0—5	persistent	sparse, extensively ramified			none
Phytophthora parasitica	0—5	persistent	sparse, extensively ramified			none
Sclerotinia sclerotiorum	10—15	persistent	attenuated, with ruptured tips	sclerotia formation retarded		none
Sphaeropsis sp.	5—10	persistent	attenuated, with balloon-like swellings; partial lysis	stimulated near inhibition zone	*B.s.* (D) > *B.s.* (S)	none
Trichoderma viride	5—10	subsiding	balloon-like swellings; occasional lysis	retarded (discoloured)	*B.s.* (S) > *B.s.* (D)	slight

The results would seem to justify further work, with a view to separation and identification of the antibiotic substance involved. Its possible application in controlling citrus fruit rots, and perhaps other plant diseases, should be considered.

REFERENCES

1. Alexopoulos, C. J., Arnett, R. and McIntosh, A. V., 1938, Studies in antibiosis between bacteria and fungi, *Ohio J. Sci.*, **38**, 221 (*Rev. appl. Mycol.*, **18**, 129).
2. Anwar, A. A., 1949, Factors affecting the survival of *Helminthosporium sativum* and *Fusarium lini* in soil, *Phytopathology*, **39**, 1005.
3. Baron, A. L., 1950, *Handbook of antibiotics*, Reinhold Publ. Corp., New York, 303 pp.
4. Johnson, E. A. and Burdon, K. L., 1946, Eumycin, a new antibiotic active against pathogenic fungi and higher bacteria, incl. bacilli of tuberculosis and diphtheria, *J. Bact.*, **51**, 591.
5. Landy, M., Warren, G. H., Rosenman, S. B. and Colio, L. G., 1948, Bacillomycin: an antibiotic from *Bacillus subtilis* active against pathogenic fungi, *Proc. Soc. Exp. Biol.*, **67**, 539.
6. Littauer, F. and Gutter, Y., 1953, Diphenyl-resistant strains of *Diplodia*, *Pal. J. Bot., Rehovot Ser.*, **8** (2), 185.
7. Michener, H. D. and Snell, N., 1949, Two antifungal substances from *Bacillus subtilis* cultures, *Arch. Biochem.*, **22**, (2) 208.
8. Porter, C. L., 1940, The effect of bacterial contamination upon the subsequent growth of fungi in the same medium, *Proc. Ind. Acad. Sci.*, **49**, (1939), 75 (*Rev. appl. Mycol.*, **22**, 95).
9. Vasudeva, R. S., 1930, Studies in the physiology of parasitism. XII. On the effect of one organism in reducing the parasitic activity of another, *Ann. Bot.*, **44**, (175), 557 (*Rev. appl. Mycol.*, **9**, 798).
10. Vasudeva, R. S., 1949, Soil-borne plant diseases and their control, *Curr. Sci.*, **18**, (4), 114 (*Rev. appl. Mycol.*, **28**, 408).
11. Wallen, V. R. and Skolko, A. J., 1950, Antibiotic XG as a seed treatment for the control of leaf and pod spot of peas caused by *Ascochyta pisi*, *Canad. J. Res.*, C., **28**, 623.
12. Walton, R. B. and Woodruff, H. B., 1949, A crystalline antifungal agent, mycosubtilin, isolated from subtilin broth, *J. clin. Invest.*, **28**, 924.

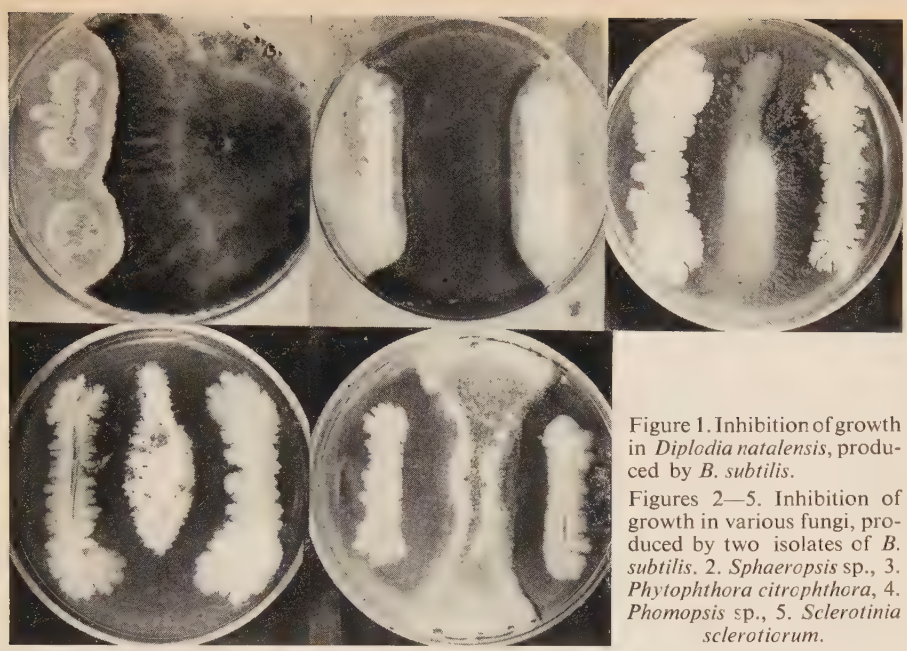
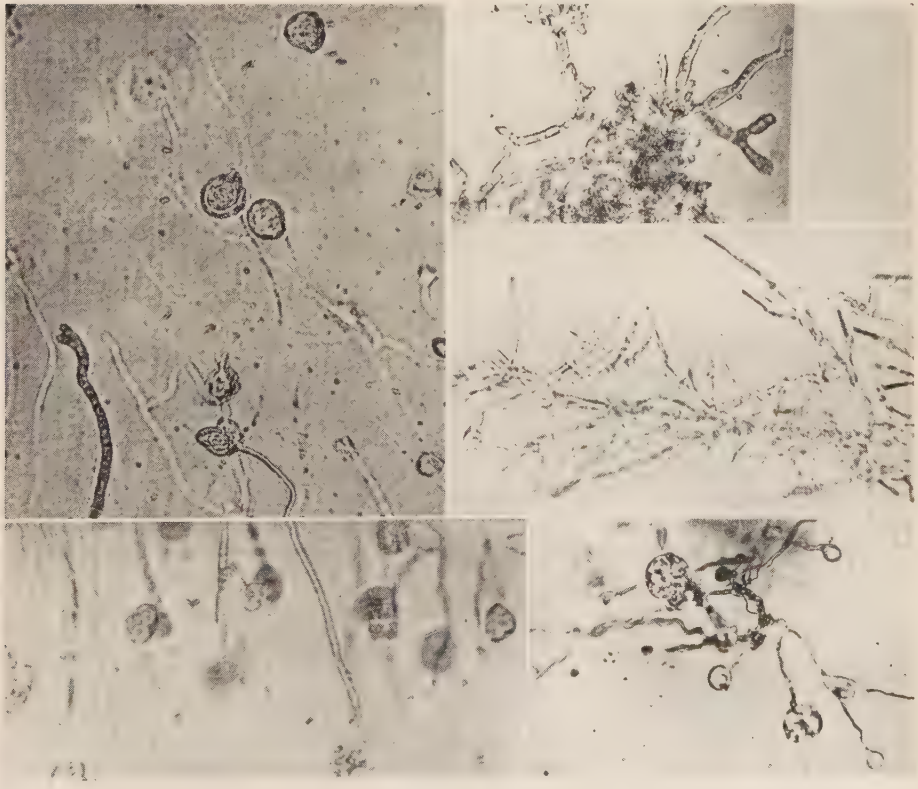


Figure 1. Inhibition of growth in *Diplodia natalensis*, produced by *B. subtilis*.

Figures 2—5. Inhibition of growth in various fungi, produced by two isolates of *B. subtilis*. 2. *Sphaeropsis* sp., 3. *Phytophthora citrophthora*, 4. *Phomopsis* sp., 5. *Sclerotinia sclerotiorum*.



Figures 6—10. Malformations in various fungi caused by *B. subtilis*. (enlarged approx. x 170).
6. *Penicillium digitatum*, 7. *Penicillium italicum*, 8. *Phytophthora citrophthora*, 9. *Oospora citri-aurantii* 10. *Diplodia natalensis*,

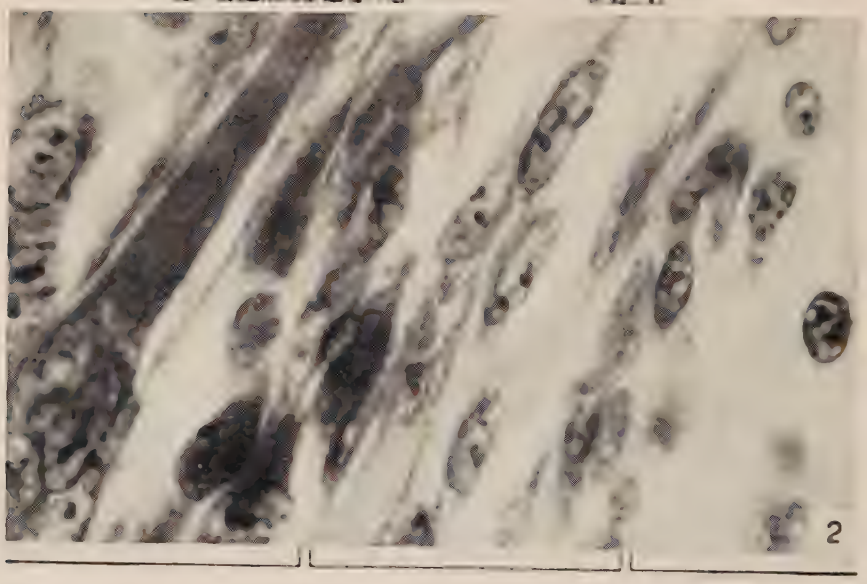


Figure 1. Development *in vitro* of a strand of muscle cells. Part of a section through a culture of 4-day chick embryo limb rudiment grown for 7 days in a medium consisting of 5 parts horse serum, 2 parts ascitic fluid (Difco), 2 parts glucose solution, supported on a membrane of bacterial cellulose. On explantation, the skinned limb rudiment consisted of undifferentiated mesenchyme. The photograph shows the attachment region of the muscle strand to a developing cartilaginous element of the limb skeleton. 8μ. Delafield's haematox.-eosine. Ocul. x10; obj. x10.

Figure 2. Early stage of the development *in vitro* of muscle tissue. Part of a section through a culture of 4-day chick embryo limb rudiment grown for 4 days as described in Figure 1. Shown are young mono- and polynuclear myoblasts developed from the myogenic tissue surrounding the chondrogenic blastema of the explant. 8μ. Delafield's haematox.-eosine. Ocul. x10; obj. x90.

DEVELOPMENT *IN VITRO* OF EMBRYONIC ORGAN RUDIMENTS ON HETEROLOGOUS ADULT TISSUE DERIVATIVES

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The usual procedures of cultivation *in vitro* of embryonic tissues, either as fragments or as organ rudiments, employ media consisting basically of a clotted mixture of plasma and chick embryo extract. Since its original introduction by Carrel (1913), embryo extract has been widely used whenever rapid and extensive outwandering and multiplication of cells were desirable in order to obtain cell colonies spreading out into the medium from the original explant. The structural disintegration of the explanted tissue resulting from the action of the embryo extract and the technique of cultivation did not matter in most of this type of work. However, with the application of tissue culture methods to problems in histogenesis and organogenesis (Fell 1951), this disruptive influence of embryo extract on the structural pattern of the explanted tissue becomes a serious disadvantage. In addition, it was found by Gaillard (1942) that when tissues from older embryos were grown on a medium containing extracts from younger embryos, the explanted tissues showed various retrogressive changes resulting in a "dedifferentiated" or degenerated condition. In the case of the chick embryo, where it is hardly practical to prepare extracts from whole embryos older than 13-14 days of incubation, this situation imposes a serious limit on the type of experimental work that can be done.

EARLIER WORK

Some time ago experiments were started to find a substitute for embryo extract which, when added to plasma or serum, would promote the orderly development *in vitro* of structurally organized tissue fragments (Moscona and Moscona 1952, 1954). The aim was to provide conditions which, though favourable for tissue growth, would not cause extensive outwandering of cells from the explant but would promote the development of the tissue according to its presumptive cellular and functional pattern.

In the first accounts of this work (ref. 16, 17) it was reported that a saline extract of acetone-dried adult fowl heart tissue (ref. 5, 14) added to fowl plasma promoted the orderly growth and development of explanted limb and pituitary rudiments of the early chick embryo. The satisfactory histotypic and organotypic differentation obtained, permitted the conclusion that a culture medium derived entirely from tissues of an adult animal could provide an adequate environment for growth of embryonic organ rudiments.

Further studies have shown that upon prolonged cultivation on the heart extract containing medium, the outwandering of fibroblasts, though less than in the presence of embryo extract, was extensive enough to result in the loss of a considerable portion of the connective tissue from the explant. As is well known, many types of tissue dif-

Received February 5, 1954.

ferentiate well *in vitro* despite such depletion. But it has also been shown (ref. 3, 12, 18) that, at least in certain instances, the typical structural development of explants depends on the presence or maintenance of the epithelial, connective and other tissues in characteristically balanced proportions. It was noted, that in certain types of explants cultivated on embryo extract or heart extract containing media, an excessive loss of connective tissue or of undifferentiated mesenchyme from the explant, resulted in deficient differentiation or arrested development. Thus, in cultures of embryonic limb buds, for instance, no myoblasts or muscle cells were usually present around the cartilaginous elements; this was, presumably, due to the fact that the mesoblasts destined to become muscle cells migrated out into the medium, acquired the shape of fibroblasts and were subsequently lost during subculturing. Related to this problem was the effect of the repeatedly renewed stimulus for cell migration provided by the frequent transfers of the explants to a fresh medium clot. This step, which is obligatory for the usual methods of cultivation, results in conditions preferential to the outwandering of connective tissue cells and thereby seriously affects the cell population of the explant.

PRESENT EXPERIMENTS

To overcome these difficulties the following procedure of cultivation was tried and found very satisfactory for the development *in vitro* of organ rudiments of the chick embryo.

A fluid culture medium was used, consisting of 4—7 parts of horse serum, 3 parts of Tyrode's (or glucosol) solution and 1—3 parts of Difco ascitic fluid. To provide mechanical support for the explant, small discs of bacterial cellulose (ref. 1, 13) were used. The cellulose discs were obtained from cultures of *Acetobacter xylinum* and the details of their preparation and use are being reported elsewhere. The chemically pure and sterile discs were soaked with the culture fluid, spread out in a watch glass enclosed in a moist chamber (a Petri dish with moist cotton) and the explant placed on it. Every 48 hours the membrane with the attached explant was rinsed in Tyrode's saline and the culture medium renewed. The tissue was never removed from the membrane and it was finally fixed for histological preparation in its original position.

Limb rudiments of 4-day chick embryos were chosen for test material as their development *in vitro* had been most exactingly studied (Fell et al. 1929, 1934). At the age of explantation they consisted of a mesoblastic primordium built of undifferentiated mesenchyme covered by epidermis. They were prepared for explantation as in previous studies (ref. 15). After five days of cultivation the explants developed into normally chondrified skeletal elements of the limb including the pelvic, femoral, tibial, fibular and some tarsal-metatarsal cartilages. These elements were embedded in a mass of myoblasts and young muscle cells many of which were arranged into typical bundles attached to the skeletal parts.

Both the cartilage tissue and the muscle cells were of the typical histological appearance. There was little fibroblastic outgrowth surrounding the cultures. The advanced histological and anatomical differentiation of the explants and their growth in size and mass were highly suggestive of favourable conditions of cultivation.

Using the same technique of cultivation, cultures of pituitary rudiments of 7-day chick embryos were examined as a sequence to previous studies on this material (ref.

16, 17). After 8 days *in vitro* the explanted epithelial vesicles developed into typically differentiated pituitary tissue with numerous characteristic chromophilic cells, the number and distribution of which was closely similar to that obtaining in the late embryo. The histological structure and the cellular differentiation reached by these explants were decisively more advanced than in previous cultures of similar material grown by other methods of cultivation.

COMMENT

The tissue-culture procedure outlined above is actually a variant of the classical watch-glass technique of H. B. Fell (1940), the fundamental principles of which are invaluable for the successful cultivation of embryonic organs *in vitro*. The introduction of a cellulose substrate and of a heterologous fluid medium do not change these principles. This modified watch-glass procedure was found to support adequately the general growth of the explanted organ rudiments, without leading to an extensive outwandering of cells. The disruptive action of the usual growth promoting agents on the tissue pattern was thus avoided; not only were there no noticeable restrictive effects on the mass increment of the explants but the degree of differentiation reached was more advanced than in similar cultures on an outgrowth promoting medium.

On the technical level, the use of heterologous media of adult origin allows for a considerable measure of standardisation of the culture medium throughout the whole series of experiments. It should also enable to produce *in vitro* nutritional and hormonal situations of deficiency or excess by suitably preparing the animal providing the medium.

The results obtained raise a number of problems which can be only briefly mentioned here. The orderly development of chick embryo tissues on a heterologous culture medium derived entirely from adult sources is a remarkable indication of the wide metabolic adaptability of embryonic tissues. The advanced degree of differentiation reached, even by explants from very young embryos, in absence of any "specific embryonic substances" clearly demonstrates that an "adult" culture medium can provide conditions suitable for the development *in vitro* of embryonic tissues. Consequently it should be concluded that the explanted embryonic rudiments were capable of directly utilising proteins and other metabolites derived from genetically completely unrelated sources for their growth requirements. This ability was, presumably, the result of an active adaptation on the part of the explants to the alien environment, enabling the tissues to utilize heterologous materials for growth in size and for differentiation according to their presumptive fates. The whole problem may in some way be related to the phenomenon of 'actively acquired tolerance' discussed by Billingham, Brent and Medawar (1953) and to the well known lack of a strong immunological reaction in early embryos to implanted homologous or heterologous tissues. Moreover, adaptation processes of this type may not be narrowly restricted to embryonic tissues ; in fact, Gaillard and Kooreman (1947) have shown that transplantations of human endocrine tissues from a new-born donor to an adult were remarkably successful if, prior to their implantation, the tissues were cultivated in the serum of its future host. This preadaptation of the implant resulted in its becoming serologically more acceptable to the host. A cautious analogy could, perhaps, be drawn here with phenomena of adaptive enzymes in bacteria.

Adaptation *in vitro* of the explant to the heterologous medium might, theoretically, proceed in one of the following ways: the tissue might reconstruct the assimilated proteins to fit its genetic and immunochemical characters, whereby its original antigenic properties would remain unchanged; or, that under the influence of the heterologous medium the antigenic properties of the explanted tissue might become altered to an extent which would make it serologically compatible with the proteins of the animal from which the culture fluid was derived. If the latter case proved true, the nature of the adaptation, whether qualitative or quantitative, would present quite a debatable problem. It should be technically possible to test these two alternatives and it is proposed to take up this matter in a future study.

Further work is now in progress to test the value of the procedure outlined here for cultivation of other embryonic organ rudiments and of tissues from new-born and adult animals.

SUMMARY

Limb and pituitary rudiments of the early chick embryo develop and differentiate *in vitro* in a culture medium consisting of adult tissue derivatives of heterologous origin, in the absence of embryo extract.

The method of cultivation used — a variant of the watch-glass technique — is briefly described. It is based on the application of cellulose membranes as a mechanical support for the tissue in a fluid culture medium.

The question is raised as to the possible serological adaptation of the embryonic tissues *in vitro* to the heterologous culture medium.

ACKNOWLEDGEMENTS

I am greatly indebted to Prof. M. Aschner of the Dept. of Bacteriology who facilitated our work by introducing us to bacterial cellulose membranes and advising us on their preparation. The help of Dr. E. Tenenbaum from the Cancer Laboratory in certain phases of this work is gratefully acknowledged. Thanks are due to Mr. R. M. Farkas for valuable technical assistance.

REFERENCES

1. Aschner, M. and Hestrin, S., 1946, *Nature*, **157**, 569.
2. Billingham, R. E., Brent, L. and Medawar, P. B., 1953, *Nature*, **172**, 603.
3. Borghese, E., 1950, *J. Anat.*, **48**, 303.
4. Carrel, A., 1913, *J. Exp. Med.* **17**, 14.
5. Doljanski, L., Hoffman, R. S. and Tenenbaum, E., 1942, *Nature*, **150**, 23.
6. Fell, H. B., 1940, *J. Roy. Micr. Soc.*, **60**, 96.
7. Fell, H. B., 1951, in *Cytology and Cell Physiology* (G. H. Bourne, ed.), Oxford.
8. Fell, H. B. and Canti, R. G., 1934, *Proc. Roy. Soc.*, **B116**, 316.
9. Fell, H. B. and Robison, R., 1929, *Biochem. J.*, **23**, 767.
10. Gaillard, P. J., 1942, *Hormones Regulating Growth and Differentiation in Embryonic Explants*, Paris.
11. Gaillard, P. J. and Kooreman, P. J., 1947, *Han. Ned. nat.-en Geneesk. XXX Congr.*, 147.
12. Grobstein, C., 1953, *J. Morph.*, **93**, 1, 19.
13. Hestrin, S., Aschner, M. and Mager, J., 1947, *Nature*, **159**, 64.
14. Margoliash, E., 1947, *Science*, **105**, 369.
15. Moscona, A. and Moscona, H., 1952, *J. Anat.*, **86**, 3, 287.
16. Moscona, A., 1954, in publication.
17. Moscona, H. and Moscona, A., 1952, *J. Anat.* **86**, 3, 278.
18. Weiss, P., 1949, in *Chemistry and Physiology of Growth* (A. K. Parpart, ed.), Princeton.

RHIPICEPHALUS BURSA IN ISRAEL

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Rhipicephalus bursa Canestrini and Fanzago 1877 is a Mediterranean species which has overflown into Southern Europe. It has been found in the Mediterranean basin and also in Rumania (Metianu 1951) and has spread to Southern USSR (Olenev 1931, Yakimoff 1923) probably through Rumania and Turkey. In Africa it has spread southward into Kenya (Lewis 1931). In Algiers it is the most prevalent tick, and Ed. Sergent et al. (1945) found it to represent 44.4% of the tick fauna there. Metianu in Rumania found it to represent only 0.5% of the tick population.

R. bursa is a species involved in the transmission of different diseases to animals, and a correct identification is therefore of a paramount importance. It has been demonstrated to transmit *Anaplasma marginale* and *Piroplasma bigeminum* in cattle, *Babesiella motasi* and *P. ovis* to sheep. Experimentally it has transmitted also *P. caballi* to a horse (Enigk 1943). The species is not very common in Israel, and among ca. 2800 adult specimens of *Rhipicephalus* sp. examined from different hosts, only ca. 30 were *R. bursa* (ca. 1%).

The main hosts of *R. bursa* in Israel in the preimaginal stages as well as the imaginal stages are sheep and goats. A few ticks, in the imaginal and preimaginal stages, were found on cattle and mules.

The larvae and nymphs were found to feed normally on sheep and goats in Israel. They attach themselves to the deepest parts of the ear, sometimes as far as the tympanum. Exceptionally some nymphs were found feeding on the udder of a cow.

It is interesting to note that Pavlovskii and Pomeranzev (1934) found that sheep, cattle and horses are the hosts of the adults, and that the larvae and nymphs do not feed on sheep. Daubney and Hudson (1934), carrying out transmission experiments with Nairobi sheep disease also did not succeed in inducing larvae to feed on the ears of sheep. Partially fed larvae and nymphs removed by us from the ears of sheep and goats, were fed in the laboratory on rats, and ungorged and partially gorged nymphs were fed on rats and *Meriones tristrami*. We did not succeed in feeding larvae hatched in the laboratory on *Meriones tristrami*.

During December—March larvae and nymphs were found feeding in the external ear canal of sheep and goats. The few adults which we have been able to take off hosts were taken in the beginning of the summer during May—June (1 gorged female in October on a mule).

The great individual variability within the species of the genus *Rhipicephalus* has been observed and studied by Nuttall (1913) in *R. appendiculatus* and by Cunliffe in *R. pulchellus*, (1913) and *R. sanguineus* (1914). Zumpt (1942) has studied the variation in the adults of *R. bursa* and has shown the great variability of the offspring of one female, in size,

Received October 20, 1953.

punctation, form of anal plates and shape of stigma. Nuttall and Cunliffe ascribed the variations to interference by the host and detaching of larvae and nymphs before the completion of feeding. Zumpt has shown that the small specimens are not necessarily the issues of nymphs which had been taken off the host before completing their feed. He has also obtained small imagines from normal sized nymphs.

The variations in *R. bursa* appear not only in adults and nymphs with an incomplete feed during the previous stage. As will be shown later, marked variations are found in the scutum of the larvae.

LARVA

Body oval; ca. 0.5 mm in length. Alloscutum with 9 festoons (Figure 1,C). Scutum wider than it is long. The length of the scutum is very variable. The ratio of length to width varies considerably; values as different as e.g. 4/6 and 5/6 have been observed (Figure 2). The mean length of the scutum is about 0.29 mm. The basis capituli is rectangular and has no lateral angles (Figure 1). By this last character the larva is easily distinguished from that of *R. sanguineus* Lat. 1806 or *R. secundus* Fel. Muh. 1952. The palps are short and large, dentition of the hypostome is 2/2, 6—7 teeth per file. There are only hints of spurs on the coxae.

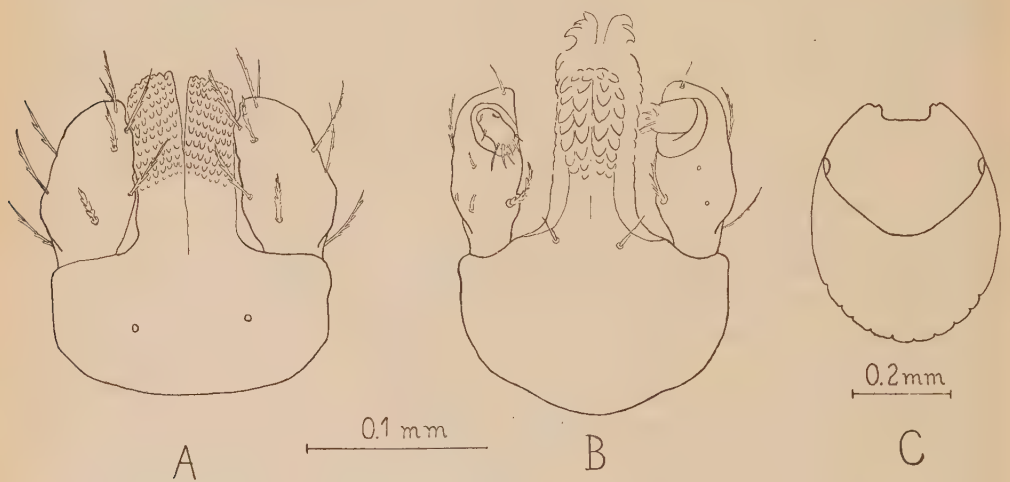

Figure 1
Larva. A—Capitulum, dorsum, B—Capitulum, venter. C—Body.

Figure 2
Scutums of two larvae, offspring of the same female.

It should be pointed out that the length of the scutum is very variable, even among the offspring of one female. In one case a coefficient of variation of 6.8 ± 1.1 [(100 standard deviation/mean) $\pm$ standard error] has been observed, the length of scutum varying from 0.238 mm to 0.313 among 19 larvae. Though variation is not always so extreme, among 24 offspring of another female the shortest scutum measured 0.270 mm and the longest 0.302 mm, the coefficient of variation being only 2.85 ± 0.41. It might be mentioned that in the genus *Hyalomma*, where also a large range of variation in different characters exists in adults (Delpy 1936, Adler and Feldman-Muhsam 1948), such a variability has not been encountered in the larvae (Feldman-Muhsam 1948). Among the offspring of two females of *H. excavatum* coefficients of variation in the length of the scutum were 2.8 ± 0.5 and 2.7 ± 0.6. In *H. dromedarii* it was found to be 2.5 ± 0.4.

NYMPH

The nymph is easily distinguished from that of *R. sanguineus* or *R. secundus* by the form of the capitulum. The body is oval, about 1.4×0.9 mm. Its colour is pale yellow, it is very poorly chitinized. The scutum is generally wider than it is long, but its length is very variable.

The basis capituli has very blunt lateral angles. The palps are large (Figure 3). The first article of the palp bears ventrally a short branched hair. The legs are stout (Figure 6). Coxa I with two long spurs. Coxae II, III and IV with one spur (Figure 4).

The stigma is rounded without a tail and contains many small elements (Figure 5). The gorged nymph may reach more than 4 mm in length. Its colour varies from yellow to red-brown.

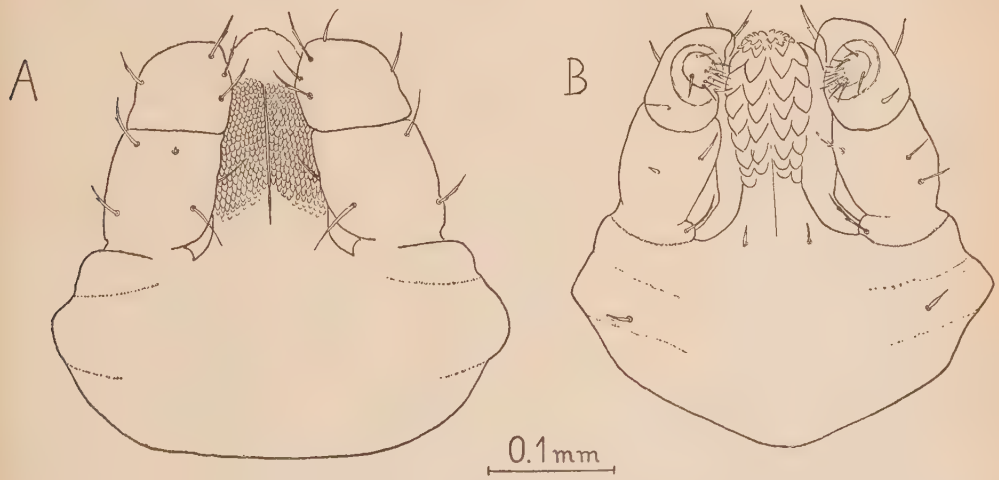

Figure 3
Nymph. A—Capitulum, dorsum. B—Capitulum, venter.

MALE

The form of the scutum is a large oval. The colour of the scutum is generally red-brown. It is covered with large punctation. The lateral grooves are long and conspicuous; sometimes they include one festoon. There are 11 festoons. The cervical grooves are

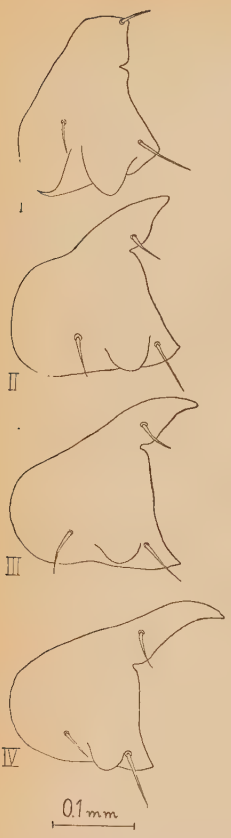

Figure 4
Nymph. Coxae I, II, III, & IV.

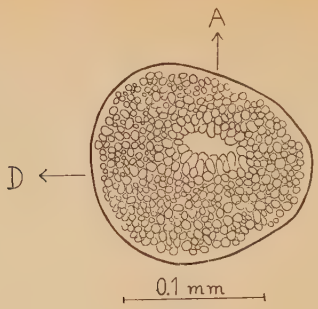

Figure 5
Nymph. Stigma.

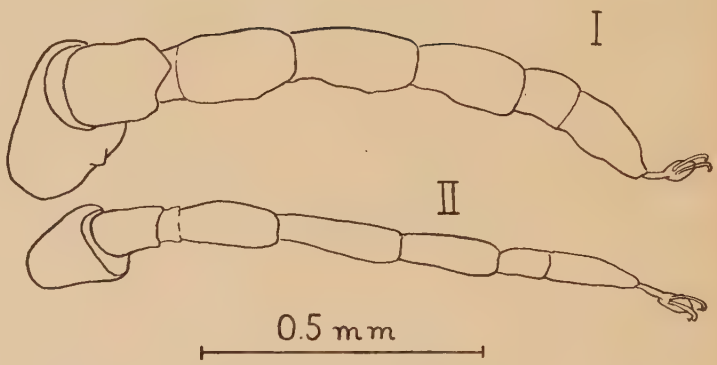

Figure 6
Fourth leg of nymphs of *R. bursa* (I) and *R. sanguineus* (II).

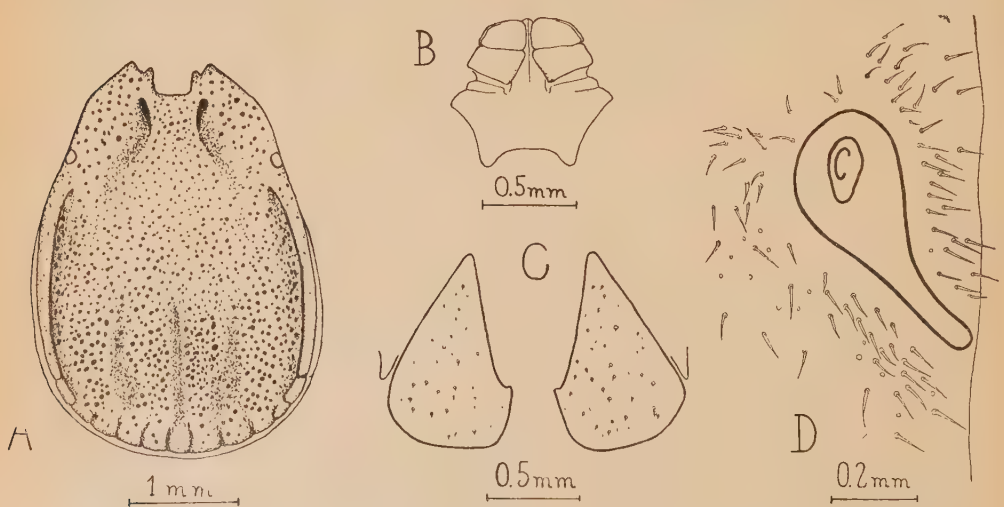

Figure 7
Male. A—Scutum. B—Capitulum, dorsum. C—Anal plates. D—Stigma.

narrow and reach a little behind the eyes (Figure 7,A). The eyes are more rounded and less flat than in *R. sanguineus*.

The basis capituli is 1.5 times wider than it is long and has well pointed lateral angles as in the other species of *Rhipicephalus*. Cornua long and well developed (Figure 7,B). The palps are large and short.

The stigma has a short and narrow tail (Figure 7,D). It is surrounded with hairs and is easily distinguished by this character from many other species of *Rhipicephalus*. (Similar peristigmal hairs are present in *R. evertsi*).

The anal plates are very characteristic. They are large and have a triangular shape with small and pointed prominences on their internal aspect. The adanal plates are small and pointed (Figure 7,C). The whole ventral tegument is very pilose, especially between the coxae. Coxa I is deeply bifid; coxae II and III with one spur. Coxa IV with two spurs.

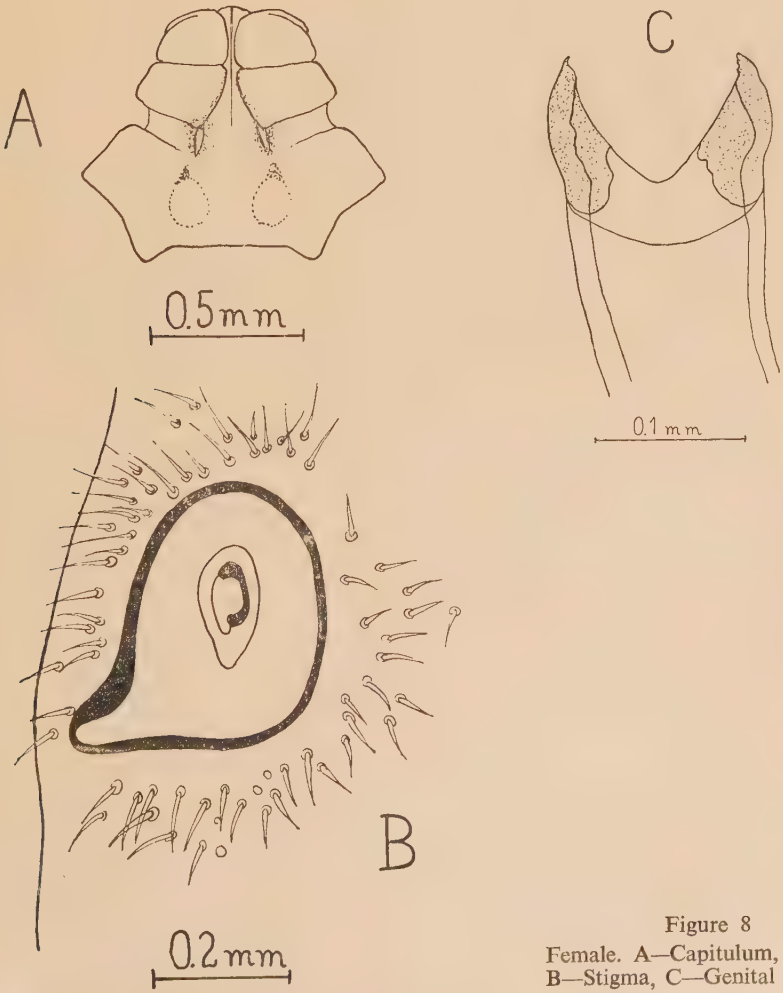

Figure 8
Female. A—Capitulum, dorsum, B—Stigma, C—Genital aperture.

FEMALE

The colour of the tick is light red-brown. The colour of the legs is somewhat lighter than that of the scutum. The length and form of the scutum as well as its punctation are variable. There are specimens where the length of the scutum equals its width and others where the scutum is wider than it is long. The punctation might be coarser or finer. The eyes are as in the male. There are well formed cornua. The stigma (Figure 8) is surrounded with hairs as in the male. The external genital aperture when examined under the stereoscopic microscope has the form of a widely opened V with a rounded base. The cleared and mounted genital aperture (Figure 8,C) has the form of a widely open cup. The two flaps on the sides are more chitinized than the base. In specimens from North Africa, kindly sent by Prof. Ed. Sergent, the genital aperture showed the above characters.

REFERENCES

1. Adler, S. and Feldman-Muhsam, B., 1948, A note on the genus *Hyalomma* in Palestine, *Parasitology*, **39**, 95.
2. Cunliffe, N., 1913, The variability of *R. pulchellus*, *ibid.*, **6**, 204.,
3. Cunliffe, N., 1914, *R. sanguineus*: Variation in size and structure due to nutrition, *ibid.*, **6**, 372.
4. Daubney, R. and Hudson, J. R., 1934, Nairobi sheep disease; Natural and experimental transmission by ticks other than *R. appendiculatus*, *ibid.*, **26**, 496.
5. Delpy L., 1936, Note sur les *Ixodides* du Genre *Hyalomma*, *Ann. de Parasit.*, **14**, 206.
6. Enigk, K., 1943, Die Uebertraeger der Pferdpiroplasmose, ihre Verbreitung und Biologie, *Arch. wiss. prakt. Tierheilk.*, **78**, 209.
7. Feldman-Muhsam, B., 1948, On larvae and nymphs of some species of Palestinian *Hyalomma*, *Parasitology*, **39**, 138.
8. Feldman-Muhsam, B., 1952, On the identity of *R. sanguineus* Lat., *Bull. Res. Counc. of Israel*, **2**, 187.
9. Lewis, A. E., 1931, A study of the ticks in Kenya Colony. The influence on natural conditions and other factors on their distribution and the incidence of tick-borne diseases, *Bull. Dept. Agric. Kenya*, No. 17.
10. Metianu, T., 1951, Contribution a l'étude des *Ixodides* de Roumanie, *Ann. de Parasit.*, **26**, 446.
11. Nuttall, G. H. F., 1913, *R. appendiculatus:* variation in size and structure due to nutrition, *Parasitology*, **4**, 195.
12. Olenev, N. O., 1931, Die Zecken (*Ixodoidea*) der Fauna Russlands, *Z. Parasitenk.*, **4**, 126.
13. Pavlovskii, E. N. and Pomeranzev, B. I., 1934, Contribution to the question of the distribution of ticks in the zone of pastures on the western slope of Alagez. *Trans. Conn. Study industr. Resources, Ser. Transcaucas. Leningrad. Acad. Sci.* pt. 11, pp. 49-62.
14. Sergent, Ed. et. al., 1945, *Etudes sur les Piroplasmoses Bovines*, Institut Pasteur d'Algerie.
15. Yakimoff, W. L., 1923, A propos des *Ixodides* de Russie, *Parasitology*, **15**, 253.
16. Zumpt, F., 1942, Die Variationsbreite der Nachkommen eines Weibchens von *R. bursa*, *Z. Parasitenk.*, **12**, 444.

THE FRESHWATER FISHES OF PALESTINE. AN ANNOTATED LIST

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INTRODUCTION

1. The only comprehensive list of freshwater fishes of Palestine is that of Bodenheimer (1937), in which 35 species are enumerated. The fact that the present paper contains a considerably lower number of species, although two new species have been added, is primarily due to the elimination of synonyms and secondly to the fact that species were refuted because they had no reliable backing of collected specimens or any other kind of evidence generally accepted in taxonomy.

2. With regard to the organisation of the present paper the following points may be useful. No claim is made of completeness of the list of literary records of the species. They refer, as a rule, to specimens of Palestinian origin. Only those records have been included that are important for the systematic position of the species and for its nomenclature and those rendering certain taxonomic details or locality statements; mere citations of records of previous authors are listed if found in works devoted to the fauna of Palestine*. But in a few cases the record list includes references to the original description of the species even if not referable to specimens from Palestine. Such records and any other not concerned with Palestinian material are not headed by the year of publication but followed by it.

In rendering the specific names given by the authors initial capitalshave been abandoned.

Abbreviations indicating the kind of information the records contain are:

descr. — description of the species,
taxon. — selected structural details (there is no definite line between this and the former category),
syst. — discussion of systematic position,
loc. — locality, more restricted than "Palestine",
spec. — certain specimens are the base of the record,
coll. — collected by.....

3. The collections referred to repeatedly as including specimens which were collected in Palestine are:

Paris Mus. — Muséum National d'Histoire Naturelle, Paris, France.
Brit. Mus. — British Museum (Nat. Hist.), London, England.
H.U. Zool. — Department of Zoology, The Hebrew University of Jerusalem, Israel.
Ind. Mus. — Indian Museum, Calcutta, India.
Istanbul Coll. — Zoologi Enstitüsü, Istanbul Universitesi, Turkey.
Lyon Mus. — Muséum d'Histoire Naturelle, Lyon, France.
Torino Mus. — Museo di Zoologia della Università di Torino, Italy.
U.S. Nat. Mus. — United States National Museum, Washington D.C., U.S.A.
Vienna Mus. — Naturhistorisches Museum, Wien, Austria.

4. Only the following of the species accepted in the present paper are not represented in the Department of Zoology of The Hebrew University:

Barbus beddomi
Barbus continii
Varicorhinus sauvagei
Phoxinellus zeregi
Nemachilus leontina

* The paper of Sauvage (1884) and the book of Gruvel have not been found useful in this respect.

Received April 24, 1953.

5. The geographic term "Palestine" has been attributed to varying areas by the authors. The boundaries of Palestine adopted for the purpose of this paper are those of the former British Mandatory territory of that name.

6. Fishes introduced from foreign countries are not included in the present list.

CYPRINIDAE

Barbus

1. *B. canis* C.V.

1842 *Barbus canis* Cuvier-Valenciennes, vol. 16, p. 140, pl. 468. Descr. spec. nov., spec. coll. Bové. Paris Mus. (types). Type locality: Jordan.
1843 *Luciobarbus canis* Heckel, vol. 1(2), p. 1097. Change of generic name only.
1864 *Labeobarbus canis* Günther, Rep., p. 490. Loc., spec. coll. Beddome and Tristram; Brit. Mus.
1866 *Labeobarbus canis* Tristram, p. 432. Loc.
1868 *Barbus canis* Günther, vol. 7, p. 109. Descr., Loc., spec. coll. Tristram; Brit. Mus.
1883 *Barbus canis* Lortet, p. 161, pl. 12:1. Descr., Loc. (? coll. Lortet, ? Lyon Mus.).
1884 *Barbus canis* Tristram, p. 174, pl. 20:1. Loc.
1893/94 *Barbus canis* Barrois.
1912 *Barbus canis* Aharoni, p. 435. Loc.
1913 *Barbus canis* Annandale, p. 31.
1926 *Barbus canis* Vinciguerra, p. 221. Taxon., syst., loc., spec. coll. Contini; Genova Mus.
1935 *Barbus canis* Hornell, p. 83. Spec. coll. Govt. of Palest.
1935 *Barbus canis* Bodenheimer.
1937 *Barbus canis* Bodenheimer.
1937/38 *Barbus canis* Tortonese, p. 20. Taxon., loc., spec. coll. Festa; Torino Mus.
1938 *Barbus canis* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.

Barbus canis has a simple record. A few alterations of the generic name are of no importance for our purpose. The species identity has never been questioned.

Günther (Catalogue) based the determination of specimens he had from Palestine on having the Paris types examined. Of all the subsequent reports of the species only those of Vinciguerra and Tortonese (1937/38) are essential for the taxonomy.

2. *B. longiceps* C.V.

1842 *Barbus longiceps* Cuvier-Valenciennes, vol. 16, p. 135, pl. 467. Descr. spec. nov., loc., spec. coll. Bové; Paris Mus. (types). Type locality: Jordan.
1843 *Luciobarbus longiceps* Heckel, vol. 1(2), p. 1097. Change of generic name only.
1864 *Barbus longiceps* Günther, Rep., p. 490. Loc., spec. coll. Tristram; Brit. Mus.
1866 *Barbus longiceps* Tristram, p. 432. Loc.
1868 *Barbus longiceps* Günther, vol. 7, p. 91. Descr., loc., spec. coll. Tristram; Brit. Mus.
1883 *Barbus longiceps* Lortet, p. 163, pl. 13:1. Descr., loc. (? coll. Lortet; ? Lyon Mus.).
1884 *Barbus longiceps* Tristram, p. 174, pl. 20:2. Loc.
1912 *Barbus longiceps* Aharoni, p. 435. Loc.
1913 *Barbus longiceps* Annandale, p. 31.
1926 *Barbus longiceps* Vinciguerra, p. 220. Loc., spec. coll. Contini; Genova Mus.
1935 *Barbus longiceps* Hornell, p. 83. Spec. coll. Govt. of Palestine.
1935 *Barbus longiceps* Bodenheimer.
1937 *Barbus longiceps* Bodenheimer.
1938 *Barbus longiceps* Norman and Trewavas, p. 555. Loc., spec. coll. Washbourn.

Barbus longiceps is as much an undisputed species as the preceding one. The Paris type was examined for comparison when Günther (1868) described the specimens collected by Tristram. Lortet gave another description.

3. *B. beddomi* Günther

1868 *Barbus beddomi* Günther, vol. 7., p. 110. Descr. spec. nov., loc., spec. coll. Beddome; Brit. Mus. (type).
1884 *Barbus beddomi* Tristram, p. 174.
1913 *Barbus beddomi* Annandale, p. 31.
1935 *Barbus beddomi* Bodenheimer.
1937 *Barbus beddomi* Bodenheimer.

The bulk of Mr. Beddome's fish collection was recorded by Günther in 1864. However, it seems that the specimen of *B. beddomi*, the only one ever collected, was presented to the British Museum at a later date and its description was prepared only for vol. 7 of the Catalogue (by inference from Günther, 1868).

The descriptive account is very short; no figure has ever been published of the species. The knowledge of the genus *Barbus* has greatly increased since the original description

of *B. beddomi* appeared. Therefore, a reexamination of the type is necessary before the systematic position of the species within the genus can properly be judged.

4. *B. continii* Vinciguerra

1926 *Barbus continii* Vinciguerra, p. 221. Descr. spec. nov., loc., spec. coll. Contini; Genova Mus. (type).
1935 *Barbus continii* Bodenheimer.
1937 *Barbus continii* Bodenheimer.

This is another example of *Barbus* known from a single specimen. Fortunately the author of this species gave as much information on it as is required by modern systematics. Differential characters determining the relationship of *B. continii* with the closely allied *B. canis* are particularly emphasized.

Varicorhinus

5. *V. damascinus* (C.V.) 1842.

Gobio damascinus Cuvier-Valenciennes, 1842, vol. 16, p. 240, pl. 482.
Scaphiodon socialis Heckel, 1843, vol. 1, p. 1057, pl. 5:1.
Chondrostoma syriacum Cuvier-Valenciennes, 1844, vol. 17, p. 303, pl. 514.
1864 *Scaphiodon capoeta* Günther, Rep., p. 490. Loc., coll. Beddome and Tristram; spec. Brit. Mus.
1864 *Scaphiodon capoeta* Steindachner, p. 223. Loc. (?), spec. coll. Kotschy; Vienna Mus.
1866 *Scaphiodon capoeta* Tristram, p. 104. Loc.
1868 *Capoeta damascina* Gunther, vol. 7, p. 77. Descr., loc., spec. coll. Beddome and Tristram; Brit. Mus.
1883 *Capoeta damascina* Lortet, p. 160, pl. 16:1. Descr., loc., (? spec. coll; ? Lyon Mus.).
1883 *Capoeta socialis* Lortet, p. 159, pl. 15:3. Descr., loc., (? spec. coll.; ? Lyon Mus.).
1883 *Capoeta syriaca* Lortet, p. 155, pl. 14. Descr., loc., (? spec. coll.; ? Lyon Mus.).
1884 *Capoeta damascina* Tristram, p. 172. Loc.
1884 *Capoeta socialis* Tristram, p. 173. Loc.
1884 *Capoeta syriaca* Tristram, p. 173. Loc.
1893/94 *Capoeta damascina* Barrois.
1893/94 *Capoeta socialis* Barrois.
1912 *Capoeta socialis* Aharoni, p. 435. Loc.
1912 *Capoeta syriaca* Aharoni, p. 435. Loc.
1913 *Varicorhinus damascinus* Annandale, p. 31.
1913 *Varicorhinus socialis* Annandale, p. 31.
1913 *Varicorhinus syriacus* Annandale, p. 31.
1926 *Varicorhinus damascinus* Vinciguerra, p. 224. Taxon., loc., spec. coll. Contini; Genova Mus.
1926 *Varicorhinus syriacus* Vinciguerra, p. 225. Taxon., loc., spec. coll. Contini; Genova Mus.
1935 *Varicorhinus damascinus* Bodenheimer, p. 417. Loc.
1935 *Varicorhinus socialis* Bodenheimer.
1935 *Varicorhinus syriacus* Bodenheimer.
1937 *Varicorhinus damascinus* Bodenheimer.
1937 *Varicorhinus socialis* Bodenheimer.
1937 *Varicorhinus syriacus* Bodenheimer.
1937/38 *Varicorhinus damascinus* Tortonese, p. 21. Taxon., syst., loc., spec. coll. Festa; Torino Mus.
1938 *Varicorhinus damascinus* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.

Günther (1868) dismissed the name *Scaphiodon capoeta* which he had given first (1864) to specimens collected in Palestine, and replaced it by *Capoeta damascina*. A reexamination of Cuvier-Valencienne's type of *Gobio damascinus*, carried out for Günther, convinced the latter that the numerous* Palestinian specimens fitted into this species.

Scaphiodon socialis Heckel was observed to be identical with *S. capoeta* (= *V. damascinus*) by Steindachner. While Heckel had only a few fishes for study, Steindachner relied on the many** specimens collected from Asia Minor down to Palestine. Günther (1868) drawing his conclusion mainly from material which originated in Palestine (more than 20 individuals), confirmed that *socialis* fell within *damascinus*. In spite of this, Lortet, Hankó (p. 146) and Pellegrin (1928, p. 38) maintained the separation of the two species. It is therefore worth pointing out that by lining up a large number of *V. damascinus* one finds all the characters claimed by Lortet to be distinctive of *socialis*.

Günther was the first author to emphasize the variability of *V. damascinus*. Its similarity to *V. syriacus* was also recognized early and observations pointing to the difficulty of keeping the species apart, were made frequently. The question of the *damascinus-syriacus* relationship cannot be understood unless a few steps of its literary treatment are rendered in summary. Günther had some 20 specimens of *Varicorhinus* from Palestine: none fitted the definition of *syriacus*, but all of them could be assigned to *damascinus*. Vinciguerra examined 8 specimens from Lake Tiberias: two of them were

* Apparently more than twenty three.
** Steindachner remarked that the Vienna Museum was "unendlich reich" in specimens of this species collected by Kotschy.

assigned to *damascinus*, six to *syriacus*. Tortonese (1937/38) studied 53 specimens from Palestine and had 50 more (collected by Festa on the same expedition) from Transjordan, Lebanon and Syria. He gives a most valuable detailed report of his findings, discusses the systematic points in question and concludes that Günther and Lortet might even have given the name *Capoeta syriaca* to two different fish species*. But concerning the material studied by himself he observes that he had no difficulty in identifying the 103 specimens of Festa as *V. damascinus*. It is an amazing result of a collecting tour like Festa's, leading through areas where *V. damascinus* as well as *V. syriacus* are said to be very common, that so large a number of *V. damascinus* was caught, but not a single *V. syriacus*.

Examining *Varicorhinus* from many different localities within Palestine for many years we have found it impossible to arrange them in two different groups. The more specimens one sees, varying in age, maturity, seasonal-reproductive stage etc., the less possible one finds this task. None of the distinctive characters employed so far, singly or in combination, stands the test of application to a large sample of specimens. We have, therefore, ceased to use *V. syriacus* as a valid name. It appears that Kosswig (1952) who made an extensive survey of the Anatolian freshwater fishes, is about to adopt the same view.

6. *V. sauvagei* (Lortet)

1883 *Capoeta sauvagei* Lortet, p. 154, pl. 13:2. Descr. spec. nov., syst., loc., spec. coll. Lortet; ? Lyon Museum (type).
1884 *Varicorhinus sauvagei*, Tristram, p. 174.
1913 *Varicorhinus sauvagei* Annandale, p. 31.
1935 *Varicorhinus sauvagei* Bodenheimer.
1937 *Varicorhinus sauvagei* Bodenheimer.

The original description, based on the only specimen known, lacks important details. The shape of the mouth and associated parts is no made clear. Three other characters are emphasized: the large scales, reflected in the low longitudinal line count of 33; the short course of the lateral line proper (no tubules behind the seventh scale); one pair of barbels. On the basis of the first of these characters, Lortet remarked that *C. sauvagei* is similar to *C. dillonii* (Heckel) (= *Varicorhinus beso* Rüpp.) which is found in Africa. Vinciguerra also favours inclusion in *Dillonia* Heckel, reduced to subgeneric standing by Günther (1868) to embrace the large-scaled species of *Capoeta*. Boulenger (1909/16) did not subdivide *Varicorhinus* into subgenera, but used the number of scales in the longitudinal line as also the number of barbels as decisive characters in his system. In 1927, Pellegrin excepted from *Varicorhinus* the species having the lateral line incomplete. For them he established the new genus *Hemigrammocapoeta*. It would not be justifiable to conclude from the scanty points reported by Lortet that *V. sauvagei* might belong to *Hemigrammocapoeta*. But it is obvious how important a revision of the species would be in the light of advanced systematics. It becomes still more so for a discussion of the zoogeographical connections of Palestinian *Varicorhinus* species, as will be shown in another paper (in preparation). Here it may be noted briefly that of the systematic characters mentioned above more taxonomic importance and more phylogenetic weight should be attributed to gross differences in the size of scales than to the number of barbels or to the completeness of the lateral line.

* If so, we wonder to which.

Garra

7. *G. rufus* (Heckel) 1843.

Discognathus rufus Heckel, vol. 1, p. 1070, pl. 8:2. Type locality: Aleppo.
1864 *Discognathus rufus* Günther, Rep., p. 490. Loc. extra Palest., spec. coll. Tristram; Brit. Mus.
1868 *Discognathus lamta* Günther partim, vol. 7, p. 69. Descr., syst., loc. extra Palest., spec. coll. Tristram; Brit. Mus.
1883 *Discognathus lamta* Lortet, p. 153, pl. 16:4, 5. Descr., loc., ? spec. coll.; ? Lyon Mus.
1884 *Discognathus lamta* Tristram, p. 172. Loc. extra Palest. (see above Günther).
1884 *Discognathus rufus* Tristram, l. c., pl. 19:3 (inconsistent with preceding item).
1893/94 *Discognathus lamta* Barrois. Loc.
1912 *Discognathus lamta* Aharoni, p. 435. Loc. (questioned, see Steinitz 1951 a).
1913 *Discognathus lamta* var. *rufus* Annandale, p. 36, fig. 2. Taxon., syst., loc., spec. coll. Annandale; Ind. Mus.
1921 *Garra rufus* Hora, p. 681. Descr., syst., loc., spec. coll. Annandale; Ind. Mus.
1926 *Discognathus rufus* Vinciguerra, p. 225. Syst., loc., spec. coll. Contini; Genova Mus.
1935 *Discognathus rufus* Bodenheimer, p. 417. Loc.
1937 *Discognathus lamta rufus* Bodenheimer.
1937/38 *Garra rufus* Tortonese, p. 15, fig. 1. Descr., syst., loc., spec. coll. Festa; Torino Mus.

The second record listed above refers to Tristram's specimens caught outside Palestine (Ramoth Gilead). We include it (and the following one) here because it became the starting point of a dispute on the systematic place of Palestinian *Garra* and, necessarily, of the relation between the species *rufus* Heckel and *lamta* Ham.-Buch. (1822).

Lortet discovered this species in Palestine proper. Although the fish is rather common, none of the collections seem to include a sufficiently great number of *Garra* from Palestine and, at the same time, of *G. lamta* from India to make a full study of the relationship of these fishes of different geographic origin.

The various descriptions and figures published do not make the issue clear. Studying about 35 specimens "from the most distant localities" Günther (1868) was satisfied that Heckel's species *rufus* was not different from *lamta* Ham.-Buch*. Annandale recognized a close relationship between the fish from Lake Tiberias and that from India (*lamta*) but maintained a subspecific difference; he named the fishes from Palestine *Discognathus lamta-rufus*. Barbel and submental disc were illustrated as distinctive features. Hora reexamined Annandale's material (9 individuals). He proposed to return to a specific separation of Near East and Indian specimens without, however, mentioning sufficient reasons for his step.

Günther (1868) already realized the considerable variability of specimens from the same locality and the marked differences between old and young individuals. Vinciguerra, examining 8 specimens from Lake Tiberias, noted that Annandale's distinctive characters were of no help in making the determination. Indeed, any fairly sized sample of Palestinian *Garra* demonstrates the inconstancy of disc and barbel features. Even Hora did not rely on them. But what the latter suggested as distinctive characters was equally impracticable in Tortonese's experience when he studied 28 specimens from the Near East (8 from Palestine, the remainder from Transjordan, Lebanon and Syria). The present author is in complete accord with Tortonese.

Although the practically unlimited material available from Palestine suffices to give a full description, the taxonomic problem can be approached only with ample material of *G. lamta* from India. Since so far no character has proven to be distinctive we join Tortonese in applying Heckel's denomination *rufus* to our *Garra* with regard to its geographic distribution.

Tylognathus

8. *T. steinitziorum* Kosswig

1950 *Tylognathus steinitziorum* Kosswig, p. 412; fig. 7-10. Descr. spec. nov., syst., loc., spec. coll. H. Steinitz; Istanbul Coll. (type and cotype).

* Disclaiming, herewith, his earlier report on Tristram's specimens as *D. rufus*.

Kosswig compares the new species with the other members of the genus. It is pointed out that the Palestinian *Tylognathus* is to be placed in the subgenus *Tylognathus* s.s. The species has been found only in the Jordan system. It is abundant in Lakes Huleh and Tiberias. We were amazed by the fact that so common a fish should have been unknown until recently.

Acanthobrama

9. *Acanthobrama terrae-sanctae* H. Steinitz

1883 *Alburnus sellal* Lortet ? partim (nec Heckel), p. 169, pl. 16:2.
1884 *Alburnus sellal* Tristram ? partim, p. 176.
1913 *Alburnus sellal* Annandale p. 31.
1926 *Alburnus sellal* Vinciguerra ?, p. 219. Taxon, syst., loc., spec. coll. Contini; Genova Mus.
1935 *Alburnus sellal* Hornell ?, p. 83. Spec. coll. by Palest. Govt.
1935 *Alburnus sellal* Bodenheimer.
1937 *Alburnus sellal* Bodenheimer.
1938 *Alburnus sellal* Norman and Trewavas ?, p. 556. Loc. spec. coll. Washbourn.
1952 *Acanthobrama terrae-sanctae* H. Steinitz, p. 293, fig. 1. Descr. spec. nov., syst., loc., spec. coll. H. Steinitz; H.U. Zool.

Lortet is most probably the discoverer of this species, which he thought to be identical with *Alburnus sellal* Heckel. Because of the occurrence in the same places of another species of the same genus, *A. lissneri* Tortonese, very similar to *A. terrae-sanctae*, it is impossible to know whether Lortet had included in his account both of them. The question as to which species Vinciguerra, Hornell, Norman and Trewavas had before them can only be decided by examination of their respective specimens. It is only because of the greater probability that, if only one species was before them, it was *A. terrae-sanctae* (which is much more abundant), that we have placed the records of the authors mentioned with the latter species, but not with the other one.

It is of considerable interest to note that the genus *Alburnus* is not represented in Palestine, but that the genus *Acanthobrama* is firmly established in this country. The systematic implications of the *Alburnus-Acanthobrama* problem have been discussed earlier (Steinitz 1952). The zoogeographical implications of *Acanthobrama* in Palestine will be presented in a forthcoming paper (Steinitz 1953).

10. *A. lissneri* Tortonese

1883 ? *Alburnus sellal* Lortet ? partim, p. 169.
1952 *Acanthobrama lissneri* Tortonese, p. 271. Descr. spec. nov., syst., loc., spec. coll. Steinitz; Torino Mus. (types) and Brit. Mus. (paratype).

Tortonese assumes that this species "was certainly confused with [*Alburnus*] by previous investigators" (p. 272). I have briefly mentioned this point when dealing with the preceding species.

Phoxinellus

11. *P. kervillei* Pellegrin 1911

Bull. Soc. Zool. France 36, p. 107. Type locality: river Orontes, Lebanon.
1937/38 *Phoxinellus* (*Pararhodeus*) *kervillei* Tortonese, p. 30. Taxon., syst., loc., spec. coll. Festa; Torino Mus.
1938 *Phoxinellus* (? *kervillei*) Norman and Trewavas, p. 550. Loc., spec. coll. Washbourn.
1951 *Phoxinellus* (*Pararhodeus*) *kervillei* Steinitz. Descr., loc., spec. coll. Steinitz; H.U. Zool.

The first specimens of this species incorporated in a scientific collection were those collected in 1893 by Festa in Lake Huleh. They remained unnoticed for a prolonged time until Tortonese recognised them.

Berg (1907) designed the genus *Pararhodeus* for those specimens of *Phoxinellus* which had an incomplete lateral line. But most ichthyologists did accord to this character not more than subgeneric value, as demonstrated by Tortonese.

Reference to the specimens collected by Washbourn in Lake Huleh and called by Norman and Trewavas *P.* (*?kervillei*) is made here with some reservation. The authors do not state why they are uncertain about the determination. We felt justified to include the record in our list because *P. kervillei* is very common in Lake Huleh, and no other species of the genus has been found there.

Recently we have given a short account of the species with emphasis on deviations of our material from that reported by previous authors.

? *P. zeregi* (Günther)

1868 *Leuciscus zeregi* Günther, vol. 7., p. 220.
1883 *Leuciscus zeregi* Lortet, p. 165.
1884 *Leuciscus zeregi* Tristram, p. 175.
1912 *Phoxinellus zeregi* Aharoni, p. 435.
1913 *Phoxinellus zeregi* Annandale, p. 31.
1933 *Phoxinellus zeregi* Berg, p. 136.
1935 *Phoxinellus zeregi* Bodenheimer, p. 427.
1937 *Phoxinellus zeregi* Bodenheimer.

This species, although collected by Beddome, was not mentioned in the report by Günther (1864); it was later listed in the Catalogue with the remark that the two specimens were "not in good state". Since it is further learned from the same record that the British Museum had no other specimens for comparison, the determination is rather doubtful. Of the later authors, only Aharoni claimed to have obtained the fish from Lake Tiberias, but there exists no material to support the diagnosis. The remaining references of the list make no claim to be based on specimens studied.

P. kervillei Pellegrin is common in Lake Tiberias. But since this species belongs to the subgenus *Pararhodeus* distinguished by an incomplete lateral line, whereas *P. zeregi* (Heckel) belongs to the typical subgenus with the lateral line complete, it is improbable that the specimens in question have been confused with *P. kervillei* unless they are very much deteriorated. Pending further study their systematic position is open to doubt.

COBITIDAE

Nemachilus

12. *N. insignis* (Heckel) 1843

Fische Syriens, 1, p. 1087, pl. 12:3. Type locality: Damascus.
1864 *Cobitis insignis* Günther, Rep., p. 190. Loc., spec. coll. Tristram; Brit. Mus.
1866 *Cobitis insignis* Tristram, p. 256, Loc.*
1868 *Nemachilus insignis* Günther, vol. 7, p. 359. Descr., loc., spec. coll. Tristram; Brit. Mus.
1883 *Nemachilus insignis* Lortet, p. 173. Loc.
1884 *Nemachilus insignis* Tristram, p. 177, pl. 19:1 (*Cobites insignis*). Loc.
1912 *Nemachilus insignis* Aharoni, p. 435. Loc.
1935 *Nemachilus insignis* Bodenheimer.
1937 *Nemachilus insignis* Bodenheimer.
1937/38 *Nemachilus insignis* Tortonese, p. 34. Descr., loc., spec. coll. Festa; Torino Mus.

The type specimens of this species are probably in the Vienna Museum. Between Günther (1868) and Tortonese (1937/38) nobody has described Palestinian specimens. Tortonese's report is important. He bases it on 6 specimens from Palestine proper and 45 more from Transjordan.

N. insignis, as well as the species mentioned below, *N. galilaeus*, is by no means rare in Israel. Specimens in the H. U. Zool., assumed to belong to this species, are at present under investigation by Prof. H. Rendahl, Stockholm. We expect a critical study of our material to be published soon** along with a similar one of the following species.

* As to this locality, see Steinitz (1951 a).
** Personal information, courtesy Prof. Rendahl.

13. *N. galilaeus* (Günther)

1864 *Cobitis galilaea* Günther, Rep. p. 439. Descr., spec. nov., loc., spec. coll. Beddome; Brit. Mus. (type).
1868 *Nemachilus galilaeus* Günther, vol. 7, p. 355. Descr., loc., spec. coll. Beddome; Brit. Mus.
1883 *Nemachilus galilaeus* Lortet, p. 173.
1884 *Nemachilus galilaeus* Tristram, p. 177, fig. 19:2 (*Cobite galilaeus*).
1913 *Nemachilus galilaeus* Annandale, p. 31.
1935 *Nemachilus galilaeus* Bodenheimer.
1937 *Nemachilus galilaeus* Bodenheimer.

Since Günther established the species *N. galilaeus* from the type locality of Lake Tiberias no descriptions of other specimens have appeared. Specimens of the H. U. Zool. attributed to this species are under investigation by Professor Rendahl, Stockholm.

? *N. leontina* Lortet

1883 *Nemachilus leontina* Lortet, p. 171, pl. 18:1.
1884 *Nemachilus leontina* Tristram, p. 177.
1913 *Nemachilus leontina* Annandale, p. 32.
1935 *Nemachilus leontina* Bodenheimer.
1937 *Nemachilus leontina* Bodenheimer.

The original description of the species by Lortet is the only contribution to the knowledge of this fish. We were unable to find out whether specimens were collected by him and possibly passed on to the Lyon Museum. The systematics of the *Cobitidae* has changed since Lortet's discovery and revisions of the Near East representatives of the family, now in progress (Tortonese, Rendahl), will produce another picture. In the meantime, opinion on the validity of *N. leontina* must be reserved.

CLARIIDAE

Clarias

14. *C. lazera* C.V. 1840

Hist. Nat. Poiss., vol. 15. p. 278. Type locality: Syria.
1864 *Clarias macracanthus* Günther, Rep., p. 490. Loc., spec. coll. Tristram; Brit. Mus.
1864 *Clarias macracanthus* Günther, Cat., vol. 5, p. 429. Loc., spec. coll. Tristram; Brit. Mus.
1866 *Clarias macracanthus* Tristram, p. 439. Loc.
1883 *Clarias macracanthus* Lortet, p. 151, pl. 17. Descr., loc., spec. coll. ?
1884 *Clarias macracanthus* Tristram, p. 169, pl. 19:1. Loc.
1893/94 *Clarias macracanthus* Barrois.
1907 *Clarias lazera* Boulenger, P. Z. S. Lond., p. 1073. Descr., syst.; mat. in Brit. Mus. not specified.
1911 *Clarias lazera* Boulenger, p. 235. Descr., loc., spec coll. Tristram; Brit. Mus.
1912 *Clarias macracanthus* Aharoni, p. 435. Loc.
1913 *Clarias lazera* Annandale, p. 32, 38. Loc., spec. ? coll.; ? Ind. Mus.
1926 *Clarias lazera* Vinciguerra, p. 219. Loc., spec. coll. Contini; Genova Mus.
1935 *Clarias lazera* Hornell, p. 83. Spec. coll. by Palest. Govt.
1935 *Clarias lazera* Bodenheimer.
1937 *Clarias lazera* Bodenheimer.
1938 *Clarias lazera* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.

The type locality of *C. lazera* called "Syrie" by Cuvier-Valenciennes is too indefinite to permit the conclusion that the fish was caught in Palestine, although the collector, Bové, had obtained other fishes from Palestine. But Tristram's specimens, given to the British Museum, are unchallenged as to their geographic origin and are, therefore, quoted here as the first ones collected in Palestine. Günther determined them (1864) as *C. macracanthus*, a species he had created to include 5 specimens from Africa. Günther, in his Catalogue (vol. 5), discriminated between *C. macracanthus* and *C. lazera*. The latter species was represented by 9 specimens, also from Africa.

In 1907, Boulenger, revising the *Clariinae*, included *macracanthus* within *C. lazera* C.V.* This unification he based on the study of more than 110 specimens in the British Museum as well as on that of the Paris type of *lazera*.

CICHLIDAE

Frequent and far reaching changes have been introduced in the systematics of the *Cichlidae* during the last 55 years. More recently, a revision of the Cichlids of Palestine

* Incidentally, *C. orontis* Günther and *C. syriacus* C. V. were also united with C. *lazera* C. V.

and Syria contributed essentially to the clarification of taxonomic problems of our particular region. The summary of those developments given below is preceded by a list of the most important works involved.

1898, 1899 G. A. Boulenger, A Revision of the African and Syrian Fishes of the Family Cichlidae. Parts I, II.
1903 J. Pellegrin, Contribution a l'Étude Anatomique, Biologique et Taxonomique des Poissons de la Famille des Cichlidés.
1915 G. A. Boulenger, Catalogue of the Freshwater Fishes of Africa in the British Museum (Natural History), vol. 3.
1920, 1922 T. Regan, The Classification of the Fishes of the Family Cichlidae, Parts I, II.
1942 E. Trewavas, The Cichlid Fishes of Syria and Palstine.

Boulenger (1898/99) shows that the term *Chromides* used so far for the family is inadmissible and has to be replaced by *Cichlidae* Bleeker (1859). He also explains that the generic name *Chromis* cannot be retained for *Sparus niloticus* L. *Tilapia* Smith (1840) is the proper generic name to be applied. Consequently he replaces *Chromis* by *Tilapia* in the species *nilotica*, *galilaea*, *zillii*, *magdalenae*, *simonis*, *flavii-josephi*. By that time distinction between the first three and the last three species with regard to their generic status had not yet been made. The generic position of *Hemichromis sacra* Günther was also altered. Günther had put the then new species *sacra* in *Hemichromis* Peters (1857) in view of the dentition. Boulenger then declared that since *sacra* had the symphysial teeth not enlarged it did not fit in Peters' genus and must, instead, be assigned to *Paratilapia* Bleeker (1868). The classification of the genera of the *Cichlidae* is based in these two papers chiefly on the dentition.

Pellegrin in his comprehensive study of the *Cichlidae* founded a new genus *Astatotilapia* devised to contain a few species with 3 anal spines and the dentition different from *Tilapia* as well as from *Paratilapia* but, at the same time, intermediate between them. *Tilapia flavii-josephi* was ascribed to this genus*. The position of all the other *Cichlidae* under discussion remained unchanged.

Boulenger (1915) dealt only with those of the Palestinian Cichlids that have a wide distribution; *Astatotilapia* Pellegrin is dissolved and *A. flavii-josephi* transferred to the genus *Haplochromis* Hilgendorf (1888)*.

Regan in his work bases the distinction of genera essentially on the osteology with special emphasis on the junction between skull and upper pharyngeal bones. Two types result from an examination of the family with this view in mind. Gross changes became necessary in Boulenger's arrangement because some of his genera contained both of the new types of Regan. The first type has the articulation chiefly on the parasphenoid: *Tilapia* (of which the type species *sparrmanni* shows this feature) belongs to this type; Boulenger's genus *Paratilapia* is split up by the decisive character, and the species *sacra* having a pure parasphenoid articulation comes under the same type. For the latter species a new, monospecific, genus is formed by Regan: *Parachromis*. — The second type of Cichlid genera has the articulation of the upper pharyngeals on the parasphenoid and the basioccipitals: *Haplochromis* falls here.

The most recent revision of the generic classification of Palestinian Cichlids by Trewavas is based on Regan's work just cited. In addition to the articulation between the parts mentioned two other characters are equally used, the position of the vertebral apophysis supporting the air bladder, and the dentition on the lower pharyngeal bones. Of all the species designated up to 1942 as *Tilapia* it is *magdalenae* and *simonis* which are said to have the apophysis at the fourth vertebra; the same species have a middle group of teeth of the lower pharyngeal enlarged. These characters are not only

* That *A. flavii-josephi* was, incidentally, united with *A. desfontainesii* (Lac.) is of no importance at this stage. But the question will be taken up below, under the heading of *Haplochromis flavii-josephi*.

common to the species *simonis* and *magdalenae*, but to *sacra* as well. In the latter species they had been recognized by Regan who had made them generic characters of *Parachromis*. The species *sacra*, *simonis* and *magdalenae* are, therefore, more similar to each other than the latter two to the other species of *Tilapia* (*nilotica*, *galilaea*, *zillii*) that are distinguished by having the air-bladder supporting apophysis on the third vertebra and no outstanding middle group of teeth on the lower pharyngeal. While these last marks again confirm the systematic position of *nilotica*, *galilaea* and *zillii* within *Tilapia* as accepted since Boulenger (1898), the species *sacra*, *simonis* and *magdalenae* are united by Trewavas in the new genus *Tristramella* which is the true successor genus of *Parachromis* adapted to comprise several different species.

Tilapia

15. *T. galilaea* (Artedi)

1757 *Sparus galilaeus* Artedi in Hasselquist, Iter, p. 343. Descr. spec. nov., loc., spec. coll. Hasselquist.
1758 *Sparus galilaeus* Linnaeus, Syst. 10th ed., 1, p. 282.
1762 *Sparus galilaeus* Artedi in Hasselquist, Reise, p. 389.
1766 *Sparus galilaeus* Artedi in Hasselquist, Voyages, p. 224.
1766 *Sparus galilaeus* Linnaeus, Syst., 12th ed., p. 473.
1862 *Chromis* (?) *galilaeus* Günther, vol. 4, p. 273*.
1864 *Chromis niloticus* Steindachner, p. 226. Taxon., syst., spec. coll. ? Kotschy; Vienna Mus. (see Boulenger, 1899).
1883 *Chromis microstomus* Lortet, p. 139, pl. 8:1. Descr. spec. nov., loc., spec. coll. ? Lortet; ? Lyon Mus.
1883 *Chromis tiberiadis* Lortet, p. 135, pl. 6. Descr. spec. nov., loc., spec. ? coll. Lortet; ? Lyon Mus.
1884 *Chromis microstomus* Tristram, p. 167.
1884 *Chromis tiberiadis* Tristram, p. 164. Loc.
1884 *Chromis niloticus* Tristram, pl. 18:1.
1893/94 *Chromis microstomus* Barrois.
1899 *Tilapia galilaea* Boulenger, p. 114. Descr.
1903 *Tilapia galilaea* Pellegrin, p. 311. Descr., loc., spec. coll. ? Lortet, Letourneux.
1912 *Chromis microstomus* Aharoni, p. 434. Loc.
1913 *Tilapia galilaea* Annandale, p. 32.
1915 *Tilapia galilaea* Boulenger, vol. 3, p. 169. Descr., loc., spec. coll. Tristram; Brit. Mus.
1926 *Tilapia tiberiadis* Vinciguerra, p. 212. Taxon., syst., loc., spec. coll. Contini; Genova Mus.
1926 *Tilapia microstoma* Vinciguerra, p. 213. Taxon, syst., loc., spec. coll. Contini; Genova Mus.
1935 *Tilapia galilaea* Hornell, p. 84. Spec. coll. Govt. of Palest.
1935 *Tilapia microstoma* Bodenheimer.
1935 *Tilapia galilaea* Bodenheimer
1937 *Tilapia microstoma* Bodenheimer.
1937 *Tilapia galilaea* Bodenheimer.
1938 *Tilapia galilaea* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.
1942 *Tilapia galilaea* Trewavas, p. 530. Descr., loc., spec. coll. Tristram, Craig-Bennett, Hornell, Bewsher; Brit. Mus.

T. galilaea is, incidentally, the first fish species from Palestine reported in a scientific publication (Hasselquist). The obvious similarity of *T. galilaea* and *T. nilotica* caused disputes between experts in early years (Günther 1862: *Chromis* (?) *galilaeus*; Günther 1864: *Chromis nilotica*; Steindachner 1864**). Tristram gave a figure of *T. galilaea* marked *Chromis niloticus* which was subsequently refuted by Boulenger (1899) and others. Lortet correctly recognized *T. nilotica*, but besides this species he discovered what he thought represented two different and entirely new species, *Chromis tiberiadis* and *C. microstomus*. The abundant material which Boulenger (1899) had for his revision of the African and Syrian Cichlids contained the evidence that it was actually impossible to separate *C. tiberiadis* from *microstomus* and, on the other hand, he had no other way but including both in *T. galilaea*. Pellegrin in his broad study of the Cichlids supports Boulenger's conclusions.

Vinciguerra obtained 14 specimens from Lake Tiberias and attributed them to two species, *T. tiberiadis* (Lortet) and *T. microstoma* (Lortet). He confirmed Lortet's observation of a difference in both species of the length/height index, but relied even more on the size of the mouth as expressed in new terms***. However, Vinciguerra's efforts in this respect are not convincing. The application of the new character implies the construction of a body horizontal which is in itself ill-defined. Having tentatively drawn

* The Catalogue contains essentially an abstract from Hasselquist's report. At that time (1862) there was not a specimen of this species in the Brit. Mus.
** Steindachner's opinion was later rejected by Boulenger (1899) and others and, more recently, by Vinciguerra.
*** Position of the mouth corner as related to a vertical through the nostril.

such a line, one will find the character of the one species combined in one individual with the length/height index of the other species.

No ichthyologist depending on specimen examination has followed Vinciguerra's lead. Trewavas (1942) gave the most recent analytical account of *T. galilaea* of which the British Museum had at that time 17 specimens from Palestine. The distinction between *T. galilaea* and *nilotica* is made entirely clear; in the first place the lower pharyngeal bones must be used for this purpose.

16. *T. nilotica* (L.) 1757

Labrus niloticus Linnaeus in Hasselquist, p. 346.
Labrus niloticus Linnaeus, 1758, Syst., 10th ed., p. 286.
1864 *Chromis nilotica* Günther, Rep., p. 490. Loc., spec. coll. Tristram; Brit. Mus.
1866 *Chromis nilotica* Tristram, p. 248; 439. Loc.
1883 *Chromis niloticus* Lortet, p. 137, pl. 7. Descr., loc., spec. ? coll.*
1884 *Chromis niloticus* Tristram, p. 164**. Loc.
1893/94 *Chromis nilotica* Barrois.
1899 *Tilapia nilotica* Boulenger, p. 112. Descr., spec. in Brit. Mus.
1912 *Tilapia nilotica* Aharoni, p. 434. Loc.
1913 *Tilapia nilotica* Annandale, p. 32; 38. Loc., spec. coll. Annandale; ? Ind. Mus.
1915 *Tilapia nilotica* Boulenger, vol. 3, p. 162. Descr., loc., spec. coll. Tristram; Brit. Mus.
1926 *Tilapia nilotica* Vinciguerra, p. 214. Loc., Taxon., spec. coll. Contini; Genova Mus.
1935 *Tilapia nilotica* Hornell, p. 84. Spec. coll. Govt. of Palest.
1935 *Tilapia nilotica* Bodenheimer, p. 432. Loc.
1937 *Tilapia nilotica* Bodenheimer.
1937/38 *Tilapia nilotica* Tortonese, p. 43. Loc., spec. coll. Festa; Torino Mus.
1938 *Tilapia nilotica* Norman and Trewavas, p. 556. Loc. spec. coll. Washbourn.
1942 *Tilapia nilotica* Trewavas, p. 528. Descr., loc., spec coll. Tristram, Craig-Bennett, Hornell, Bewsher, Washbourn; Brit. Mus.

Reference should be made to *T. galilaea* which is very close to *nilotica*. It has been shown there that substantial dispute was created in the past by that relationship of the species. Details may be found there. Both species are well represented in many collections and can be easily studied also on the spot where they are abundant. The safest identification is made if the lower pharyngeals are resorted to. Trewavas (1942) added to this character a few more reliable, but less readily recognizable ones.

16a. *T. nilotica exul* H. Steinitz

1866 *Chromis nilotica* Tristram, p. 256. Loc.
1912 *Chromis andreae* Aharoni, p. 434. Loc.
1951a *Tilapia nilotica exul* H. Steinitz, p. 531. (Nomen nudum!). Loc.
1951b *Tilapia nilotica exul* H. Steinitz, p. 513. Descr. subsp. nov., syst., loc., spec. coll. Mendelssohn and Steinitz; H.U. Zool. (types).

This *Tilapia*, discovered by Tristram and briefly but aptly commented on by him with regard to its behaviour, was again seen in the type locality, Ein Feshkha, by Aharoni, who accompanied Blanckenhorn on his Dead Sea excursion. While Tristram secured two specimens***, it is not clear whether Aharoni actually caught any of these fishes.

Steinitz made a study of the fish on the base of 28 specimens. It was evident that certain constant differences existed between the typical *T. nilotica* from Palestine and the population of Ein Feshkha. This situation made it necessary to establish a subspecies for the latter.

17. *T. zillii* (Gervais) 1848

1864 *Chromis andreae* Günther, Rep., p. 492. Descr. spec. nov., loc., spec. coll. Tristram; Brit. Mus. (types).
1883 *Chromis andreae* Lortet, p. 142, pl. 8:3 (descr. copied?; ? spec, Lyon Mus.).
1884 *Chromis andreae* Tristram, p. 165, pl. 17:1. Loc.
1899 *Tilapia zillii* Boulenger, p. 119. (spec. in Brit. Mus.).
1903 *Tilapia zillii* Pellegrin, p. 327. Loc., spec. coll. Letourneux; ? Paris Mus.
1913 *Tilapia zillii* Annandale, p. 38. Loc., spec. coll. Annandale; ? Ind. Mus.
1915 *Tilapia zillii* Boulenger, vol. 3, p. 197. Loc., spec. coll. Tristram; Brit. Mus.
1926 *Tilapia zillii* Vinciguerra, p. 216. Taxon., loc., spec. coll. Contini; Genova Mus.
1935 *Tilapia zillii* Hornell, p. 84. Spec. coll. Govt. of Palest.
1935 *Tilapia zillii* Bodenheimer, p. 414, 432. Loc.
1937 *Tilapia zillii* Bodenheimer.
1937/38 *Tilapia zillii* Tortonese, p. 41. Taxon., loc., spec. coll. Festa; Torino Mus.
1938 *Tilapia zillii* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.
1942 *Tilapia zillii* Trewavas, p. 531. Descr., loc., spec.coll. Tristram, Craig-Bennett, Hornell, Buxton, Aharoni; Brit. Mus.

* No material from the Lyon Mus. is mentioned by Pellegrin (1903).
** The plate figure 18:1, named *Chromis nilotica*, is, in fact, a *T. galilaea*.
*** Not listed by Trewavas (1942), p. 530, where two other specimens of *T. nilotica*, collected by Tristram in Palestine, are mentioned.

This species was discovered in Palestine by Tristram. He gave 3 specimens to the British Museum. Günther believed them to represent a new species which he named *Chromis andreae* with the type locality Lake Tiberias. Later, Lortet added to his own description a figure of the fish (no evidence of specimens presented to the Lyon Museum). The figure published by Tristram one year later is superior. Boulenger (1898, 1899) was aided by the material concentrated in the British Museum during nearly 35 years following Tristram's discovery. Boulenger realized that *C. andreae* was identical with *Tilapia zillii* (Gervais), known at that time from Africa only. The description of the species, revised by Boulenger (1899), demonstrated the variability of characters in *T. zillii* which amply allowed for the inclusion of the fishes from Palestine. Four years later, Pellegrin again revised the *Cichlidae*, using chiefly the material accumulated in the museums of France. He examined many specimens (59) of *T. zillii* from Africa, and two from Lake Tiberias collected by Letourneux, and confirmed the point of view of Boulenger (1899). Boulenger's (1915) description of *T. zillii* did not go beyond the older one (1899), but expressedly stated the examination of the types of *Chromis andreae*. 164 African specimens had been covered by the new study. Vinciguerra had many specimens, collected in 1925 from Lake Tiberias, for his report that appeared in 1926. Tortonese, who published his report in 1937/38, had 41 specimens from different localities in Palestine, collected by Festa 50 years earlier. Both Italian accounts contain valuable information. The work of Trewavas (1942), based on 20 specimens from Palestine, included a study of the skeleton of this as well as of the other Cichlids occurring in the region; hereby the identification of every one of the species was worked out unmistakably.

For some time it was subject to doubt whether *T. zillii* is a mouthbreeder like other species of *Tilapia*. The literature was briefly reviewed by Aronson (1949, p. 134). The controversy (Liebman 1933, p. 887) is probably due to misidentification. Field observations which made it clear that *T. zillii* is not a mouthbreeder were confirmed by an elaborate study of the breeding habits of this fish in the aquarium by Dr. H. Mendelssohn (unpublished). While that investigation was in progress, Daget (1952) published a short report on his field investigations of *T. zillii* in Africa. Daget arrives at the same conclusion as Mendelssohn.

Tristramella

18. *T. sacra* Günther

1864 *Hemichromis sacra* Guenther, Rep., p. 490;493. Descr. spec. nov., loc., spec. coll. Tristram; Brit. Mus. (types).
1866 *Hemichromis sacer* Tristram, p. 430. Loc.
1883 *Hemichromis sacra* Lortet, p. 117; 148, pl. 10:1. Descr., loc., ? coll.
1884 *Hemichromis sacra* Tristram p. 168, pl. 18:2. Loc.
1893/94 *Hemichromis sacra* Barrois.
1898 *Paratilapia sacra* Boulenger, p. 139. Descr., syst., loc., spec. in Brit. Mus.
1903 *Paratilapia sacra* Pellegrin, p. 260. Descr. (no specimens on record!).
1913 *Hemichromis sacra* Annandale, p. 32; 38. Loc., spec. coll. Annandale; ? Ind. Mus.
1922 *Parachromis sacer* Regan, p. 251 (Descr. of gen. nov., monospecif.; spec. in Brit. Mus.).
1935 *Hemichromis sacer* Hornell, p. 85. Spec. coll. Govt. of Palest.
1935 *Paratilapia sacra* Bodenheimer.
1937 *Hemichromis sacer* Bodenheimer.
1942 *Tristramella sacra* Trewavas, p. 533. Descr. (=type of gen. nov.), syst. loc., spec. coll. Tristram, Craig-Bennett; Brit. Mus.

The record of this species is rather plain as far as its specific position is concerned. Its generic place, however, has changed extensively as was pointed out in the introductory paragraph devoted to the *Cichlidae*.

19. *T. simonis* (Günther)

It is extremely difficult to give a full account of the synonymy of this species (including *T. magdalenae*, see below). For this several reasons exist. While Günther described *Chromis simonis* from types collected in Lake Tiberias only, *Chromis magdalenae* Lortet

was described originally from Lake Tiberias as well as from the lakes east of Damascus. The distribution of the species *simonis* has hitherto been interpreted as strictly Palestinian (Jordan system). The distribution of *magdalenae* is not undisputed: Trewavas (1942) assumes that *magdalenae* is restricted to the Damascus region where it "represents *T. simonis*" (p. 532). The 4 specimens set on record by Trewavas from the collections of the British Museum were collected by Lortet in the Damascus area and are syntypes of the species. They are decribed by Trewavas in the manner used throughout her paper; this facilitates confrontation of closely allied forms. It thus becomes evident that these syntypes of Lortet's *magdalenae* are rather similar but not identical in structure with 3 specimens caught in Lake Tiberias by Tristram and by Franklin (l. c., p. 534)*. The latter specimens typify Trewavas' *Tristramella simonis*. With regard to the near relationship between the two distinct forms Trewavas advanced the suggestion that *magdalenae* should be considered as a subspecies of *simonis*.

Since the taxonomic questions are intricately bound up with the geographic distribution of the species as a whole, a review of the specimens dealt with in the literature is required.

Lortet (1875, 1876, 1883) reported from Lake Tiberias *Chromis simonis* (= *C. paterfamilias*) and *C. magdalenae*. It is possible that specimens of both kinds were given by Lortet to the Lyon Museum (compare Pellegrin 1903), but the descriptions published by the author are lacking the definition necessary to discern two closely related forms. Also the number of specimens examined by him seems to have been insufficient. Therefore, no clear picture of the taxonomic situation can be derived from his studies. Pellegrin (1903) examined the specimens of the Lyon Museum caught in Lake Tiberias, and felt justified to confirm Lortet's observation without, however, improving the inconclusive descriptions of that author. It must be kept in mind that Lortet had also collected specimens in the vicinity of Damascus (Syria) and these were most probably also used for making up his description of *Chromis magdalenae*. However all specimens (four) of the latter origin seem to have been acquired by the British Museum. They were reexamined by Trewavas (1942). The latter introduced the shape and dentition of the lower pharyngeal bone and the lateral-line pores in the skull as differential characters. It was possible to demonstrate in the revised description that the Damascus specimens must be regarded as representing a systematic unit by itself and distinct from *simonis*; consequently they were designated as syntypes of Lortet's *Chromis magdalenae* (l. c.). In conclusion we see that while two distinct forms of *Tristramella*, *simonis* and *magdalenae*, are found in the Near East, there is no evidence that the form *magdalenae* exists outside the vicinity of Damascus. Moreover, many years of exploration of Palestinian waters have failed to bring *T. magdalenae* to our attention.

In examining *Tristramella* specimens from Palestine assigned to *simonis*, Trewavas noticed in seven of them certain characters diverging "from the types in the direction of *T. magdalenae*". The common occurrence of such intermediate specimens can be confirmed. They are much more numerous in Lake Huleh than in Lake Tiberias. A detailed study of them showed that they form a taxonomic entity characterized by a combination of features which justifies the name *Tristramella simonis intermedia* (the description of this subspecies by Ben-Tuvia and Steinitz is due to appear soon). It is not impossible that besides the 7 specimens indicated as differing from *simonis* in Trewa-

* It seems that the first two of them listed as collected by Tristram are the types of *Chromis simonis* Günther, although no remark is made to this effect.

vas' paper, also Lortet's specimens collected in Lake Tiberias and named by him *Chromis magdalenae* belong to this subspecies.

The occurrence of a third, intermediate, form strengthens Trewavas' argument favouring the subspecific rank of *magdalenae*. As will be pointed out by Ben-Tuvia and Steinitz, *Tristramella simonis* would, then, embrace the three subspecies *simonis* s. s., *intermedia* and *magdalenae*.

In view of the complicated situation caused by two subspecies which had not been kept apart in the past, the proper rendering of records is made difficult. An attempt will be made, though; but only those records will be considered that are supported by actual material.

a. *T. simonis simonis* (Günther)

1864 *Chromis simonis* Günther, Rep., p. 490; 492: descr. spec. nov., 2 type specimens, coll. Tristram; Brit. Mus.
1875 *Chromis paterfamilias* Lortet, p. 119: descr. spec. nov., possibly based on specimens in Lyon Mus. Lortet himself later changed the name of the species to *simonis* (see below).
1876 *Chromis paterfamilias* Lortet, p. 81: figures!
1883 *Chromis simonis* Lortet, p. 143, pl. 9:1. Descr., loc.; on specimens see above.
1884 *Chromis simonis* Tristram, p. 165, pl. 17:2. Loc.
1899 *Tilapia simonis* Boulenger, p. 125: redescription based on type.
1903 *Tilapia simonis* Pellegrin, p. 321: description based on Lyon (and Paris) specimens.
1926 ? *Tilapia simonis* Vinciguerra, p. 215: loc., 2 specimens in Genova Mus. The few details reported by the author don't make it clear beyond doubt that the subsp. *simonis* is meant.
1942 *Tristramella simonis* Trewavas *partim*, p. 533: descr., loc. Here fall the types (in Brit. Mus.) of Tristram and the specimens collected by Franklin.

b. *T. simonis intermedia* Ben-Tuvia and H. Steinitz.

1883 ? *Chromis magdalenae* Lortet, *partim*, p. 146 (? pl. 9:2). Descr., loc., 1 specimen in Lyon Mus. from Tiberias.
1903 ? *Tilapia magdalenae* Pellegrin *partim*, p. 320: descr.; 1 specimen from Lake Tiberias in Lyon Mus., probably the material of Lortet (1883). (It is not made clear whether the description is meant to include the London specimens from Damascus which Pellegrin might well have studied when in London!).
1926 ? *Tilapia magdalenae* Vinciguerra, p. 215: 1 spec. coll. Contini from Lake Tiberias. The few details reported do not permit classification with certainty.
1942 *Tristramella simonis* Trewavas *partim*, p. 533: descr., loc. Here fall the 7 specimens in the Brit. Mus. mentioned as deviating from the types of *simonis*.

For the sake of clarity the third subspecies, assumed not to be existent in Palestine, may be treated here in brevity:

c. *T. simonis magdalenae* (Lortet)

1883 *Chromis magdalenae* Lortet *partim*, p. 146 (? pl. 9:2).
1899 *Tilapia magdalenae* Boulenger, p. 120.
1942 *Tristramella magdalenae* Trewavas, p. 535.

Haplochromis

20. *H. flavii-josephi* (Lortet)

1883 *Chromis flavii-josephi* Lortet, p. 141, pl. 8:2. Descr. spec. nov., loc., spec. coll. Lortet; Brit. Mus. (types). Type locality: "Ain-el-Tabigah, Syria"*.
1884 *Chromis flavii-josephi* Tristram, p. 167.
1893/94 *Chromis flavii-josephi* Barrois.
1899 *Tilapia flavii-josephi* Boulenger, p. 135. Descr., syst., material in Brit. Mus.
1903 *Astatotilapia desfontainesii* Pellegrin *partim*, p. 300; 302. Description, syst. (No specimens from Palestine on record; Brit. Mus. specimens studied?)
1912 *Chromis flavii-josephi* Aharoni, p. 434. Loc.
1913 *Tilapia flavii-josephi* Annandale, p. 32.
1915 *Haplochromis desfontainesii* Boulenger *partim*, vol. 3. p. 303. Descr., loc., syst., spec. coll. Lortet; Brit. Mus.
1922 *Haplochromis flavii-josephi* Regan, p. 262. Redescr. of types, syst., loc., spec. coll. Lortet; Brit. Mus.
1926 *Haplochromis flavii-josephi* Vinciguerra, p. 218. Syst., loc., spec. coll. Contini; Genova Mus.
1935 *Tilapia flavii-josephi* Bodenheimer.
1937 *Tilapia flavii-josephi* Bodenheimer.
1937/38 *Haplochromis flavii-josephi* Tortonese, p. 45. Taxon., loc., spec. coll. Festa; Torino Mus.
1942 *Haplochromis flavii-josephi* Trewavas, p. 536. Descr., loc., spec. coll. Lortet, Craig-Bennett; Brit. Mus.

The plain reference list of *H. flavii-josephi* is interrupted only once: in 1903, Pellegrin expressed the opinion that Lortet's species is inseparable from *Astatotilapia desfontainesii* Lac., which had priority. Although the Paris Museum had no specimens, Pellegrin examined the London types (p. 301) and stated subsequently that dentition, general aspect and count characters were the same as in *desfontainesii*, while the coloration was very similar. It is remarkable that Boulenger (1915) accepted this view. Regan, however, returned to *flavii-josephi* as separate species, pointing out that it is readily recognized by the pharyngeal dentition which was not considered by the former authors, and by the lower number of scales in the longitudinal line. The separation was later confirmed by Vinciguerra and Tortonese, both of whom had examined specimens from Palestine. Trewavas finally redescribed the species with the types and three more specimens on hand. The reliability of the characters emphasized by Regan was again demonstrated and even strengthened.

The generic position of *H. flavii-josephi* was dealt with in the general paragraph on the *Cichlidae*.

* A spring on the north-west shore of, and draining into, Lake Tiberias. Spelled also Tabigha, etc.

CYPRINODONTIDAE

Aphanius

21. *A. fasciatus* (Val.) 1821

1935 *Cyprinodon fasciatus* Bodenheimer, p. 424. Loc.*
1935 *Cyprinodon calaritanus* Bodenheimer, p. 422; 424. Loc.
1937 *Cyprinodon fasciatus* Bodenheimer.
1937 *Cyprinodon calaritanus* Bodenheimer.
1937/38 *Cyprinodon fasciatus* Tortonese, p. 39. Loc., spec. coll. Festa; Torino Mus.

As differences have been stated to exist between specimens from different localities as, for instance, near Istanbul and Iskenderun (Aksiray 1948), and Cyprus (Steinitz 1952 a), a description of Palestinian specimens is highly desirable.

22. *A. cypris* (Heckel) 1843 — *sophiae* (Heckel) 1846

Lebias cypris Heckel, vol. 1, p. 1090; vol. 2(3), p. 242; pl. 19:1.
Lebias sophiae Heckel, vol. 2, p. 267; pl. 22:2.
1864 *Cyprinodon cypris* Günther, Rep., p. 490. Loc., spec. coll. Tristram; Brit. Mus.
1864 *Cyprinodon sophiae* Günther, Rep., p. 490. Loc., spec. coll. Tristram; Brit. Mus.
1866 *Cyprinodon cypris* Günther, vol. 6, p. 304. Descr., loc., spec. coll. Tristram; Brit. Mus.
1866 *Cyprinodon sophiae* Günther, vol. 6, p. 304. Descr., loc., spec. coll. Tristram; Brit. Mus.
1866 *Cyprinodon cypris* Tristram, p. 155; 256. Loc.
1866 *Cyprinodon sophiae* Tristram, p. 256 (323:?). Loc.
1883 *Cyprinodon cypris* Lortet, p. 174, pl. 10:3. Loc. (coll. spec. ?).
1883 *Cyprinodon sophiae* Lortet, p. 178.
1884 *Cyprinodon cypris* Tristram, p. 171.
1884 *Cyprinodon sophiae* Tristram, p. 172.
1895 *Cyprinodon cypris* Gaillard, p. 5. fig. 1—3.
1895 *Cyprinodon sophiae* Gaillard, p. 7, fig. 4—6.
1912 *Cyprinodon cypris* Aharoni, p. 435. Loc.
1912 *Cyprinodon sophiae* Aharoni, p. 434; 435. Loc.
1913 *Cyprinodon mento* Annandale, p. 38. Loc., spec. coll. Annandale; ? Ind. Mus.
1913 *Cyprinodon sophiae* Annandale, p. 38. Loc., spec. coll. Annandale; ? Ind. Mus.
1935 *Cyprinodon cypris* Bodenheimer, p. 417. Loc.
1935 *Cyprinodon sophiae* Bodenheimer, p. 431. Loc.
1935 *Cyprinodon mento* Bodenheimer.
1937 *Cyprinodon cypris* Bodenheimer.
1937 *Cyprinodon sophiae* Bodenheimer.
1937/38 *Cyprinodon cypris* Tortonese, p. 40. Taxon., loc., spec. coll. Festa; Torino Mus.
1938 *Lebias cypris* Norman and Trewavas, p. 556. Loc., spec. coll. Washbourn.
1948 *Aphanius cypris* Aksiray, p. 116. Descr., loc., spec. coll. H.U. Zool.; Istanbul Coll.
1951a *Aphanius ? sophiae* Steinitz, p. 531. Loc., spec. in H.U. Zool.
1951c *Aphanius cypris-sophiae* Steinitz, p. 116. Syst.

The denomination of this species as given above is preliminary. Since the taxonomic unit meant here comprises what has been called *A. sophiae* as well as *A. cypris* by most authors and since it is a matter of nomenclatural procedure to name the fish properly, the name *cypris-sophiae* has been chosen for convenience; it is also in line with earlier remarks on the systematic position of this fish (Steinitz 1951 c).

Tristram was the first to collect this species in Palestine; his finding was recorded by himself (1866, 1884) and by Günther (1864), who later described the same material in his Catalogue (1866). Lortet also observed the fish in Palestine but it is not quite clear from his paper whether he collected specimens for the Lyon Museum. It is, consequently, equally uncertain whether the description by Gaillard based on the material of the Lyon Museum, from various places, was made in consideration of Palestinian material. It is to be credited to Gaillard that *C. mento* Heckel was recognized as the female of *C. cypris* Heckel**.

In modern times specimens from Palestine were studied and described by Tortonese and Aksiray. Important contributions to the knowledge of this east-mediterranean species were also made by Pellegrin (1923), Hankó, and Sözer. Much effort was devoted by all these authors to tell *A. cypris* and *A. sophiae* satisfactorily apart. And yet nobody confronted with a large number of specimens and from different localities was convinced of the success of that procedure. Every one of the authors mentioned started anew in the attempt to tackle the problem. The conclusion that the separation of *cypris* and *sophiae* might not be justified was first suggested by H. Steinitz (1951 a, 1951 c, p.

* The particular locality, "marshes of Beisan", is probably due to an error.
** Gaillard united Heckel's two species under the name of *cypris*. Hankó, p. 157, returned to *mento* for purely nomenclatural reasons. May be Annandale had the same in mind when he used *mento*.

116). Aksiray, who has extensive experience with regard to this question, has recently given support to the same view (1952, p. 33).

23. *A.* aff. *dispar* and *richardsoni*

Under this denomination those landlocked *Aphanius* of Palestine will be dealt with which have so far been described under the specific names of *dispar* and *richardsoni*.

Several populations are known to exist in entirely separate localities. Everyone of the populations may represent a different systematic entity. There are at least indications that two of them differ from each other as well as from *A. dispar* (Rüppell). They are being studied at present in order to establish their relationship.

Many places in the close neighbourhood of the Dead Sea have been listed as being inhabited by the fishes in question. Those situated east to the former territorial boundary between Palestine and Transjordan are excluded from further discussion. Within Palestine the localities that can be identified satisfactorily are from north to south:

1. Ain es Sghair (quoted also as Ain 'Sghir, 'Ain es Zrair, Ain Jeheiyir)*, a spring not far from the place called Kallia. Lortet obtained about 40 specimens from this water body. They were given to the Lyon Museum. Gaillard later redescribed these specimens. A few more investigators have also claimed having observed *Cyprinodon dispar* in this spring, but no other specimens are on record. In the nineteen forties we visited this water body (not knowing its above mentioned name) looking for "*A. dispar*", but were unable to discover them.

2. Ein Feshkha (Ain Feshkha, 'Ain-Feschcha, Ejn Feshka), located on the Dead Sea shore, about 6 km linear distance southwest of Kallia. This group of springs, pools and rivulets, first mentioned by Tristram as biotope of "*dispar*", still has a thriving population of fish. Some ecological and faunistic data of Ein Feshkha were published by H. Steinitz in 1951. Aksiray (1948) published the first description of specimens. The Hebrew University has specimens from this point. Also, both the British Museum and the U. S. National Museum have been given specimens from this locality. The Ein Feshkha population is one of those under investigation.

3. 'Ain Terabeh (Ein et Turaba) on the west coast of the Dead Sea, at approximately 13 km linear distance from Ein Feshkha and 18 km from Kallia. Tristram listed this spring as populated by *A. dispar*. No other reference is known to us. Specimens are not on record.

4. A brine spring "near Usdum" being the type locality of *Cyprinodon richardsoni* Boulenger. Located at the north of Jebel Usdum, south west coast of the Dead Sea,more than 10 km north of the plant of the Dead Sea Works, Ltd.**, this place was described in varying detail by Richardson, Tristram (1865) and Lartet. It was also visited by Mr. Poole, who gave to the British Museum the specimens considered today as the types of *C. richardsoni* Boulenger***. The specimens collected there by Tristram are also being kept in the British Museum. Lartet's specimens can hardly be traced (fide Gaillard). — The fishes of this locality, included in the British Museum collections, are being reexamined at present and will be described in due course***. This is rendered difficult by

* I am indebted for the identification of this place to my colleague, Mr. J. Wahrman, Department of Zoology, Hebrew University. He informed me that it is almost certain.

** Much help was extended to the author by Mr. J. Wahrman with regard to the southern localities. Mr. Wahrman's efforts are gratefully acknowledged.

*** Courtesy Dr. Trewavas, in litt.

the scarcity of the material. Recently, Mr. Wahrman has searched the type locality thoroughly for fishes, but nothing was found of them.

5. At the south of Jebel Usdum, near the plant of the Dead Sea Works, Ltd., southwest corner of the Dead Sea, another population has been found. A group of springs and artificial channels are the habitat of the animals. For the sake of clarity this locality will be called South Usdum: S'dom, while the preceding one (the type locality of *C. richardsoni*) will be called North Usdum: Zuweira. Mr. Wahrman secured specimens from the southern locality; several of them were presented to the British Museum, the others are kept in the collection of the H. U. Zool. This population is the third of those studied at present.

While the outcome of the investigations mentioned is not known it is preferred to regard the various populations as separate entities and to designate them by their place of origin. A list of references is appended in which I have attempted to trace the literary sources of the various forms.

In passing it may be mentioned that:

1913 *Cyprinodon richardsoni* Annandale, p. 32; 38 — from lake Tiberias is questioned. Annandale claimed that he collected specimens of this species; they should be kept in the Indian Museum. This may be a misidentification.

Lortet's locality record of *Cyprinodon dispar*, Ain Mellahah (Lake Huleh region), is equally not accepted. It is evident from Lortet's paper (1883, p. 122) that he did not catch the species in this place. No specimen record is known from Ain Mellahah.

a. *richardsoni*: North Usdum:Zuweira

1856 Richardson, p. 371, spec. coll. Poole, Jebel Usdum; the types of Boulenger's *Cyprinodon richardsoni*, named *C. hammonis* by Richardson.
1866 Lartet, p. 721: *Cyprinodon moseas, C. hammonis*?, *C. lunatus* (compare Lortet and Gaillard). Spec. coll. Lartet.
1866 Günther partim, Cat. vol. 6, p. 303: *C. dispar*.
1884 Tristram, p. 170: *C. dispar*, near Jebel Usdum.
1907a Boulenger, p. 412: *C. richardsoni*, first naming.

b. aff. *dispar*: Ain es Sghair

1883 Lortet partim, p. 175: *C. dispar*, Ain es Sghair.
1884 Tristram partim, p. 170: *C. dispar*, Ain Sghir.
1895 Gaillard, p. 13: *C. dispar*, Ain es Sghair, coll. Frère Liévin; Lyon Mus.
1912 Aharoni partim, p. 434: *C. dispar*, Ain es Zrair.

c. aff. *dispar*: Ein Feshkha

1884 Tristram partim: *C. dispar*, Ain Feshkha. p. 170.
1912 Aharoni partim: *C. dispar*, Ain Feschcha. p. 434.
1947 Mendelsohn, p. 123: *C. dispar*. Ein Feshkha (by implication).
1948 Aksiray, p. 114: *Aphanius dispar*, Ejn Feshka.
1951a Steinitz, p. 531: *A. dispar*, Ein Feshkha.
1951c Steinitz partim: *A. dispar*.

BLENNIIDAE

Blennius

24. *B. vulgaris* Pollini 1816

1864 *Blennius lupulus* Günther, Rep., p. 490. Loc., spec. coll. Beddome, Tristram; Brit. Mus.
1866 *Blennius lupulus* Tristram, p. 104. Loc.
1883 *Blennius varus* Lortet, p. 129, pl. 18:3. Descr., loc., spec. coll. Lortet; ? Mus. Lyon.
1883 *Blennius lupulus* Lortet, p. 130.
1884 *Blennius varus* Tristram, p. 162.
1884 *Blennius lupulus* Tristram, p. 162. Loc.
1893/94 *Blennius varus* Barrois.
1913 *Blennius varus* Annandale, p. 31; 35. Loc.
1913 *Blennius lupulus* Annandale, p. 31.
1926 *Blennius vulgaris* Vinciguerra, p. 211. Taxon, loc., spec. coll. Contini; Genova Mus.
1935 *Blennius lupulus* Bodenheimer.
1935 *Blennius varus* Bodenheimer.
1935 *Blennius fluviatilis* Bodenheimer, p. 424. Loc.
1937 *Blennius lupulus* Bodenheimer.
1937 *Blennius fluviatilis* Bodenheimer.
1950 *Blennius vulgaris* Steinitz, p. 64. Descr., syst., loc.; specimens from H.U. Zool. and other collections in Israel.

B. vulgaris was discovered and for the first time collected in Palestine by Beddome in Lake Tiberias (1862) and later by Tristram in the Kishon river (1863). The specimens of both these collectors were identified as *B. lupulus* Bonap. by Günther. Günther, who had no other specimens but those from Palestine, relied on the description given by Bonaparte. Lortet, on the other side, who had also found *Blennius* in Lake Tiberias, believed his fishes to be different from Bonaparte's species, but fitting into *B. varus* Risso. It is obvious from Lortet's publication that he thought Lake Tiberias inhabited by two species of *Blennius* of which he had found but one. So thought Tristram, who was however convinced he had found the other one (1884). It is important to note that Lortet distinguished both species mentioned (*lupulus* and *varus*) from a third one (*vulgaris* Pollini) which he had found only outside of, but near to, Palestine.

The three names listed were regarded designating three different species by the authors, more by their following Günther's lead than by examining critically specimens. Later authors (Barrois, Annandale) have one or two species on their lists without discussing the reasons.

In 1926, Vinciguerra reported on 6 specimens collected from Lake Tiberias. Vinciguerra realized that these specimens matched *B. varus* Risso as well as *B. vulgaris* Pollini; the latter name had the nomenclatural priority. What relation Vinciguerra's specimen would have to *B. lupulus* was not stated in his paper.

In 1935, Bodenheimer mentions three species of *Blennius* as living in Lake Tiberias, *varus*, *lupulus* and *fluviatilis*. The latter record may, however, be a mere error, since in 1937 the same author lists only *B. lupulus* and *fluviatilis*, stating at the same time that the latter species includes *varus* and *vulgaris*.

In 1950, *Blennius* from Lake Tiberias and its tributaries was again described by Steinitz. 52 specimens were studied. Considerable variation exists with respect to most of the characters used traditionally. The same is true for other characters tentatively advanced. The study of a small number of specimens could easily suggest a partition into two different groups. This possibility apparently guided Günther as well as Lortet, but in different directions. A large number of specimens would have shown that the gap between the alleged species does not exist. — Since our 1950 paper was published we have seen many more specimens from both the lake and its tributaries. The view taken in 1950 was strengthened by the new material. Lake Tiberias (in the broader sense) is inhabited by but one species.

Since Tristram's finding of *Blennius* in the Kishon (see above), there were no more records of specimens caught in coastal rivers. It was only recently that we obtained one specimen from a coastal river (Haifa Bay; unpublished). Although this fish has not yet been subjected to detailed study, it may be mentioned that at first sight it seems not to fit into the species known from Lake Tiberias as *B. vulgaris* (Steinitz 1950). This is especially interesting with regard to the following point.

Anatolian freshwater blennies from different localities, widely separated from each other, may represent different taxonomic units (Kosswig, in litt.). The present writer, who obtained these fishes for further study, is inclined to consider them as slightly deviating also from *B. vulgaris* of Lake Tiberias and equally from the *Blennius* taken in the coastal river, but with the reservation that a refined study must be made before final conclusions can be reached. It appears not impossible that a second subspecies or species will be recognized in our local fauna besides the *Blennius* of Lake Tiberias.

APPENDIX: Species not accepted.

Varicorhinus fratercula (Heckel)

The earliest claim to the presence of this species in Palestine was made by Lortet in 1883 (p. 156). The only locality within Palestine where Lortet said to have met *V. fratercula* is Deichoun (also spelled Deishom, Deichûm, Deishum) in the upper Galilee. The Arab villagers held the fishes sacred, we are told by Lortet, and did not permit him to catch one. The diagnosis was, therefore, founded on live specimens not handled by the investigator. This procedure cannot be accepted as sound, particularly in the case of species of *Varicorhinus* that are difficult to identify even under close examination.

We have no knowledge of the present status of that water body nor of its fauna. The place itself is situated east of the country's main watershed and belongs more particularly to the area of the Wadi Hindaj system which drains into Lake Huleh. Wadi Hindaj is one of the favoured spawning grounds of *V. damascinus*.

In spite of lacking evidence the record of *V. fratercula* has been carried on. It even became a source of contradicting zoogeographical statements (Tristram 1884, p. 173; Bodenheimer 1935, p. 422; 426).

Rutilus tricolor (Lortet)

This species, too, must be questioned as inhabitant of Palestine as long as full evidence is not provided. Information is found in Bodenheimer's book (1935, p. 431) where *Leuciscus tricolor* is listed as occurring in the Yarkon River*. However, in 1937 (p. 261) Bodenheimer reduces the fish to *Leuciscus* aff. *tricolor* for reasons not given. The true identity of the specimen (or specimens) in question remains still to be settled.**

Acanthobrama centisquama (Heckel)

There is no material from Palestine on record that could be referred to this species. The source is Tristram's book (1884, p. 176); there *A. centisquama* Heckel is reported to live in the "upper affluents of the Jordan". The species was not included in Tristram's collection received by the British Museum. The finding has never been confirmed (Steinitz 1952, p. 294; compare Bodenheimer 1935, p. 417 and 427, who admits the species as Palestinian, but doubts its presence in coastal rivers). It must be mentioned that in 1862, Th. W. Beddome collected a young fish in Palestine which was subsequently designated as *Acanthobrama sp. ?* by Günther (1864, p. 490). Günther adds that "no example is in Mr. Tristram's collection". No further determination of Beddome's specimen has become known; it is also to be wondered why it has not been mentioned in Günther's Catalogue, vol. 7, 1868. The earlier record of 1864 is, consequently, more or less valueless.

Phoxinellus capoeta ?author

This species is mentioned by Sauvage (1884, p. 14) as an endemic element in Lake Tiberias. I was unable to follow this information to an earlier record, nor could I find out what the systematic position and identity of this fish may be.

Blennius semifasciatus Rüppell.

Bodenheimer (1937, p. 261) lists this species as living in the freshwater in Palestine. This is the only record; it could not be traced to earlier sources. *B. semifasciatus* is a marine blenny known from the Red Sea.

* It is not made quite clear whether the determination is due to the late Dr. J. Pellegrin.

** The record by Tortonese (1937/38, p. 28) of *Rutilus tricolor*, collected in 1893 by E. Festa "dintorni del mar Morto" and in Es-Sanamein (Syria, about 50 km east of Lake Huleh, within the Jordan-drainage) adds to the actuality of the problem.

GENERAL REFERENCE LIST

1. Aharoni, J., 1912, *Die Tierwelt des Jordantales und Toten Meer-Gebiets*. In: Blanckenhorn, M., *Naturwissenschaftliche Studien am Toten Meer*, Berlin.
2. Aksiray, F., 1948, Türkische Cyprinodontiden, I, *Rev. Fac. Sci. Univ. Istanbul.*, **B13**(2), 97-138.
3. Aksiray, F., 1952, Genetical Contributions to the Systematical Relationship of Anatolian Cyprinodont Fishes, *Publ. Hydrobiol. Res. Inst. Univ. Istanbul*, **B1**(2), 33-81, 2 pl.
4. Annandale, N., 1913, Notes on the Fishes, Batrachians and Reptiles from the Lake of Tiberias, *J. Asiat. Soc. Beng.*, **9**, 31-41.
5. Aronson, L. R., 1949, An Analysis of Reproductive Behavior in the Mouthbreeding Cichlid Fish, *Tilapia macrocephala* (Bleeker), *Zoologica, N.Y.*, **34**(16), 133—158. 3 pl.
6. Barrois, Th., 1893/94, Contribution a l'étude de quelques lacs de Syrie, *Rev. Biol. Nord. Fr.*, **6**, 224—312.
7. Berg, L. S., 1907, Beschreibungen einiger neuer Fische aus dem Stromgebiet des Amur, *Annu. Mus. zool. Acad., St. Petersb.*, **12**, 413—418.
8. Berg, L. S., 1933, Übersicht der Verbreitung der Süsswasserfische Europas, *Zoogeographica*, **1**, 107—208.
9. Bodenheimer, F. S., 1935, *Animal Life in Palestine*, Jerusalem.
10. Bodenheimer, F. S., 1937, Prodromus Faunae Palestinae, *Mem. Inst. Égypte*, **33**, II + 268 pp.
11. Boulenger, G. A., 1898, A Revision of the African and Syrian Fishes of the Family Cichlidae. Part I: *Proc. zool. Soc. Lond.*, 132—152.
12. Boulenger, G. A., 1899, *Id.*, Part II: *l. c.*, 98—143.
13. Boulenger, G. A., 1907, A Revision of the African Silurid Fishes of the Subfamily Clariinae, *Proc. zool. Soc. Lond.*, 1062—1097.
14. Boulenger, G. A., 1907a, *The Fishes of the Nile* (*Zoology of Egypt*), London.
15. Boulenger, G. A., 1911/15, *Catalogue of the Freshwater Fishes of Africa in the British Museum* (*Natural History*), *London*. Vol. 2, 1911; Vol. 3, 1915.)
16. Cuvier, G. and Valenciennes, A., 1828/49, *Histoire Naturelle des Poissons*, Paris, 22 vols. (Vol. 15, 1840; Vol. 16, 1842; Vol. 17, 1844.)
17. Daget, J., 1952, Observations sur la ponte de *Tilapia zillii* Gervais, Poisson de la Famille des *Cichlidae*, *Ann. Mag. nat. Hist.* (12), **5**, 309—310.
18. Gaillard, C., 1895, Notes sur quelques espéces de Cyprinodonts de l'Asie Mineure et de la Syrie, *Arch. Mus. Hist. nat. Lyon*, **6**(2), 1—15.
19. Gruvel, A., 1931, Les États de Syrie, richesses marines et fluviatiles, (*Bibl. Faune Colonies Franc*)., Paris **3**.
20. Günther, A., 1859/70, *Catalogue of the Fishes in the British Museum, London*, 8 vols. (Vol. 3, 1861; vol. 4, 1862; vol. 5, 1864; vol. 6, 1866; vol. 7, 1868).
21. Günther, A., 1864, Report on a collection of Reptiles and Fishes from Palestine, *Proc. zool. Soc. Lond.*, 488—493.
22. Hamilton-Buchanan, F., 1822, *An Account of the Fishes found in the River Ganges and its Branches*, Edinburgh.
23. Hankó, B., 1924, Fische aus Klein-Asien, *Ann. Mus. nat. Hungar.*, **21**, 137—158. 3 pl.
24. Hasselquist, F., 1757, *Iter Palaestinum*, Stockholm. (Also quoted from the German translation, *Reise etc.*, 1762, and the English translation, *Voyages etc.*, 1766).
25. Heckel, J. J., 1843/46, in Russeger, J., *Reisen in Europa, Asien und Afrika, etc.*, Stuttgart, 1841—1848. vol 1(2); vol. 2(3).
26. Hora, S. L., 1921, Indian Cyprinoid Fishes Belonging to the Genus *Garra* with Notes on Related Species from other Countries, *Rec. Indian. Mus.* (Calcutta), **22**, 633—687. pl. 24—26.
27. Hornell, J., 1935, *Report on the Fisheries of Palestine*, London.
28. Kosswig, C., 1950, Die Gattung Tylognathus in Vorderasien, *Ergzgsbd. z.* **145**, *Zool. Anz.*, 406—415.
29. Kosswig, C., 1952, Die Zoogeographie der türkischen Süsswasserfische. *Publ. Hydrobiol. Res. Inst. Univ. Istanbul*, **B1**(2), 85—101.
30. Lartet, L., 1865/66, Recherches sur les variations de salure de l'eau de la mer Morte, etc, *Bull. Soc. géol. Fr.*, (2), **23**, 719—760.
31. Liebman, E., 1933, Some Observations on the Breeding Habits of Palestine Cichlidae, *Proc. zool. Soc. Lond.*, 885—888.
32. Linnaeus, C., 1758, *Systema naturae*, Stockholm,10th ed. (Also quoted from 12th ed., 1766).
33. Lortet, L., 1875, Sur un poisson du lac de Tibériade, le *Chromis paterfamilias*, qui incube ses oeufs dans la cavité buccale, *C.R. Acad. Sci., Paris*, **81**, 1196—1198.
34. Lortet, L., 1876, Le *Chromis Pater Familias* du lac de Tibériade, *Nature*, Paris, **4**(1), 81—82.
35. Lortet, L., 1883, Poissons et Reptiles du lac de Tibériade et de quelques autres parties de la Syrie, *Arch. Mus. Hist. nat. Lyon*, **3**, 99—182. pl. 6—18.
36. Mendelsohn, H., 1947, A New Locality for *Cyprinodon dispar* Rüppell, *Nature, Lond.* **160**, 123.
37. Norman, J. R. and Trewavas, E., 1938, in Washbourn and Jones; see ref. No. 63.

38. Pellegrin, J., 1903, Contribution a l'Étude Anatomique, Biologique et Taxonomique des Poissons de la Famille des Cichlidés, *Mém. Soc. zool. Fr.*, **16,** 41—400. pl. 4—7.
39. Pellegrin, J., 1911, Poissons de Syrie recueillis par M. Henri Gadeau de Kerville, *Bull. Soc. zool. Fr.*, **36**, 107—110.
40. Pellegrin, J., 1923, *Étude sur les Poissons rapportés par M. Henri Gadeau de Kerville de son voyage zoologique en Syrie*, Paris (Bailliere).
41. Pellegrin, J., 1927, Description d'un Cyprinidé nouveau d'Asie Mineure. *Bull. Soc. zool. Fr.*, **52,** 34—35.
42. Pellegrin, J., 1928, *Les Poissons des eaux douces d'Asie Mineure*, Paris (Bailliere).
43. Regan, C. T., 1920/22, The Classification of the Fishes of the Family Cichlidae. I, *Ann. Mag. nat. Hist.* (9), **5,** 33—53, 1920. II, *ibid.*, (9), **10,** 249—264, 1922.
44. Richardson, J., 1856, On some Fish from Asia Minor and Palestine, *Proc. zool. Soc. Lond.*, 371—377.
45. Sauvage, H. E., 1884, Notice sur la faune ichthyologique de l'ouest de l'Asie, etc., *Nouv., Arch. Mus. Hist. nat.*, Paris (2), **7,** 1—42. Pl. 1—3.
46. Sözer, F., 1942, Contributions à la connaissance des Cyprinodontides de la Turquie, etc., *Rev. Fac. Sci. Univ. Istanbul*, **B7** (4), 307—316.
47. Steindachner, F., 1864, Ichthyologische Mitteilungen (VII), *Verh. zool.-bot. Ges. Wien*, **14,** 223—232. pl. 7—8.
48. Steinitz, H., 1950, Contributions to the Knowledge of the Blenniidae of the Eastern Mediterranean, III, *Rev. Fac. Sci. Univ. Istanbul*, **B 15** (1), 60—87.
49. Steinitz, H., 1951, *Phoxinellus* (*Pararhodeus*) *kervillei* Pellegrin from Lake Huleh, Palestine, *Bull. Res. Counc. of Israel*, **1** (1/2), 16.
50. Steinitz, H., 1951 a, The Fishes of Ein Feshkha, Palestine, *Nature, Lond.* **167,** 531.
51. Steinitz, H., 1951 b, A new subspecies of *Tilapia nilotica* (L.) from Palestine, *Ann. Mag. nat. Hist.* (12), **4**, 513—518.
52. Steinitz, H., 1951 c, On the Distribution and Evolution of the Cyprinodont Fishes of the Mediterranean Region and the Near East, *Bonn. zool. Beitr.*, **2** (1/2), 113—124.
53. Steinitz, H., 1952, *Acanthobrama terrae-sanctae*, sp. n. from Lake Tiberias, Israel, *Ann. Mag. nat. Hist.* (12), **5,** 293—298.
54. Steinitz, H., 1952 a, Notes on Fishes from Cyprus, *Bull. Inst. océanogr. Monaco*, 1004, 1—12.
55. Steinitz, H., 1953, The Distribution and Evolution of the Freshwater Fishes of Palestine. In Press.
56. Tortonese, E., 1937/38, Viaggio del dott. Enrico Festa in Palestina e in Siria (1893), Pesci, *Boll. Mus. Zool. Anat. comp. Torino*,, (3) **46**, No. 85, 3—48. pl. 1—2.
57. Tortonese, E., 1951/52, Richerche sistematico-faunistiche sui pesci d'acqua dolce dell'Anatolia. 1. *Cobitidae*, *Boll. Mus. Zool.Anat. comp. Torino*, **3** (8), 1—14.
58. Tortonese, E., 1952, On a New Cyprinoid Fish of the Genus *Acanthobrama* from Palestine, *Ann. Mag. nat. Hist.* (12), **5,** 271—272.
59. Trewavas, E., 1942, The Cichlid Fishes of Syria and Palestine, *Ann. Mag. nat. Hist.* (11), **9,** 526—536.
60. Tristram, H. B., 1866, *The Land of Israel. A Journal of Travels in Palestine, etc.*, London. 2nd ed.
61. Tristram, H. B., 1884, *Fauna and Flora of Palestine*, (Survey of Western Palestine), London.
62. Vinciguerra, D., 1926, Sopra una collezione di Pesci della Palestina, *Ann. Mus. Stor. nat. Genova,* **52,** 210—226.
63. Washbourn, R. and Jones, R. F., 1938, Report of the Percy Sladen Expedition to Lake Huleh. A Contribution to the Study of the Fresh Waters of Palestine, *Ann. Mag. nat. Hist.* (11), **2,** 517—560. pl. 16—17.

IRRIGATION STUDIES IN THE JORDAN VALLEY
I. PHYSIOLOGICAL ACTIVITY OF THE BANANA IN RELATION TO SOIL MOISTURE*

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INTRODUCTION

The study of both the physiological and agricultural aspects of irrigation is primarily concerned with the solution of practical problems confronting the farmer. The early investigations, undertaken some 70 years ago, dealt with the water requirements and transpiration ratios of various plant species. At that time, little was known of the water relations in the soil and in the plant. In both spheres, a great amount of work has been done during the last 30 years, and the understanding of the problems involved has considerably increased.

Irrigation has but one purpose, i.e. the regulation of the water supply in such manner as will ensure optimum moisture conditions for the crop. It can, therefore, be expected that the physiological activity of the crop plant and its yield would provide reliable indication as to whether optimal moisture conditions are actually being maintained. Thus, the constant observation of the responses of plants to variations in soil moisture provides the correct approach to the solution of irrigation problems.

Physiological indicators of suboptimal moisture conditions revealed by such observations are generally applicable to only one or, at most, a small number of plant species. However, the physiological indicators found suitable for such species or groups of species will be equally valid in all areas of production.

The use of physiological indicators for the determination of irrigation requirements was introduced in this country by Oppenheimer (Oppenheimer and Mendel 1939; Oppenheimer and Elze 1941).

Investigations here described were carried out over a period of 5 years: 1946, 1947 and 1949—1951. The crop plants studied were bananas, maize and cowpeas.

METHODS **

Stomatal Opening. All observations were carried out in the field on healthy, intact leaves. Four methods were employed, namely:

a) Direct microscopic examination (Stalfelt 1929)
b) Lloyd's method (Lloyd 1908)
c) Collodion-film method (Buscallioni and Pollacci 1902)
d) Infiltration method (Molisch 1912).

* Presented to the Senate of The Hebrew University of Jerusalem, in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

** Further details of the methods employed will be published elsewhere.

Received January 3, 1953.

The results of other methods were checked by direct microscopic observation. Lloyd's method was found satisfactory only with cowpeas, while the collodion film method was best suited for bananas and maize. Values indicating the extent of stomatal aperture as determined by means of the collodion film or Lloyd's method, are averages of at least ten measurements carried out on equivalent portions of three leaves of the same age and exposure. The most widely open stoma was measured in each microscopic field.

Infiltration agents were adjusted for each of the investigated crop plants in accordance with responses obtained in preliminary tests. Rates of infiltration were graded in accordance with the results of the tests, on the basis of a 100-point scale (Table I). All infiltration data represent means of at least ten determinations. Identical portions of comparable leaves of equal exposure to light were used for each series of tests.

TABLE I

Grading scale for infiltration values

Time from application of agent to manifestation of effect (seconds)	Infiltration effect	Grading value (points)	Stomatal aperture (μ)*
1	Confluent spot	100	5—8
2	„ „	100	5—7
3	„ „	90	5—6
4	„ „	80	4—6
5	„ „	70	4—5
6	„ „	60	3—5
7	„ „	50	3—4
8	„ „	40	2—4
9	„ „	30	1—3
10	„ „	20	(0)1—2
11	„ „	19	(0)1—2
12	„ „	18	0—1
13	„ „	17	0—1
14	„ „	16	0—1
15	„ „	15	0—1
15	Numerous isolated spots	10	0—1
15	Few isolated spots	5	0—1
15	No effect	0	0

* Figures in this column refer to banana (third leaf from the top).

(0) indicates presence of some closed stomata.

Transpiration. Rates of transpiration were measured by means of a sensitive transpiration balance (Huber 1927). In each case, care was taken to obtain transpiration rates from leaves or parts of leaves equivalent to those used for the determination of stomatal opening. Each value represents the mean of 2—4 weighings. Time of exposure was 2 minutes, the leaf being freely suspended on the hook of the open balance box. The balance was installed in the sun at the original level of the examined leaf.

Osmotic pressure. Determinations were made by means of the cryoscopic method (Walter 1931). Whole leaves were used in cowpeas and maize. In the case of banana, the tests were performed on the section of the leaf blade marked in Figure 4. All roots for osmotic tests were taken from a depth of 10 to 40 cm.

Root systems. Examination of roots was carried out by the trench wash method.

Soil moisture. Samples of 150—200 g dry weight were taken with an auger. Standard procedure was employed in determinations. Data reported are the means of values obtained from 4 borings in plots of banana and cowpeas, and 6 borings in plots of maize. At each irrigation interval, sampling was begun two days after irrigation, and then repeated every two to four days.

Field capacity and permanent wilting percentage were determined according to procedure described by Veihmeyer and Hendrickson (1949). The core sampling method was employed for the determination of apparent specific gravity.

CLIMATE

The climatic character of the Jordan Valley* is dominated by a combination of topographical factors, such as the deep depression below sea level (about —210 m), the relatively great distance from the Mediterranean and the additional isolation from maritime influences by a range of mountains. Data presented in Table II were recorded at the climatological station of Degania A, situated less than 1 km from the experimental fields**.

TABLE II

Some climatic data for the Jordan Valley

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	An-nual
Normal Rainfall (mm)	100.2	78.2	39.7	24.2	3.3				0.2	14.6	34.5	78.1	373.0
Temperature °C													
Daily mean	13.8	13.6	15.1	18.9	25.2	27.2	29.8	30.2	28.1	24.8	21.4	16.0	22.0
Mean maximum	18.5	18.5	20.7	25.4	32.4	34.4	36.8	37.0	31.8	31.3	27.1	20.5	28.1
Relative humidity (%)													
Daily mean	71	76	71	64	54	54	57	58	58	52	56	69	61.7
Mean at 2.00 p.m.	61	65	59	50	41	40	42	42	43	42	46	60	49.2
Evaporative Power (*Piche* mm)													
Daily mean	3.2	2.5	3.2	4.7	7.6	9.4	10.4	10.0	8.3	7.3	5.3	3.3	6.3

Rainfall is practically confined to the period between mid-October and the end of April.

Temperature. Between May and October, the mean monthly temperatures vary between 25 and 30°C while the mean monthly maximum temperatures range from 31 to 37°C. July and August are the warmest months. The maximum, in the early afternoon, coincides, more or less, with the period of lowest relative humidity and highest wind speed. At that time of the day, temperature changes are very slow.

Relative humidity. From May to November monthly means approximate 55%. Mean values for 2.00 p.m. reach 40%. At that time, mean saturation deficiency of the air may attain 30 mm Hg in some months.

Evaporation. Measurements made by means of Piche evaporimeters exposed in a double-louvered Stevenson screen gave for the period from May to October mean monthly values ranging between 7.6 and 10.4 mm per day. The highest evaporation values were recorded in July and August.

Wind. This is a prominent climatic factor in the Jordan Valley. During summer, mean velocities of 30 km/hr, as measured at a height of 14 m, are attained in the afternoon. Velocities at 2 m above the ground, amount in open fields to 65—85 percent of these values (Lorch 1951).

The various climatic factors combine thus to build up the evaporative power of the air during the period of irrigation and result in high evapotranspiration and great irrigation requirements.

SOIL PROPERTIES

The soil of all the experimental fields contained in the top 30—40 cm layer 35 to 55 percent calcium carbonate and 55 to 75 percent of the clay and silt fraction. The proportion of these constituents increased slightly with depth down to 90 cm. The field capacity ranged from 24.5 to 27.6 percent for all soils, while the permanent wilting percentage varied between 13.0 and 15.0 (Table III).

In all the experimental plots, the depth of the water table was over 3 m throughout the period of the experiments. Only very small quantities of soluble salts were present in the soil.

* The designation "Jordan Valley" is employed throughout this paper in conformity with the restricted usage current in Israel. In this connotation, the term is confined to the triangular plain bounded by Lake Tiberias in the North, by the Yarmouk in the East, and by the Jordan in the West.

** The data were kindly supplied by the Director of the Israel Meteorological Service.

TABLE III

Soil moisture constants

Depth (cm)	Field capacity (%)	Permanent wilting (%)	Available water capacity (m^3/dunam)*
	Banana, Maize and Cowpeas — 1949 (Kerak)		
0—15	25.5	14.2	20.00
15—30	24.6	14.0	18.92
30—45	25.0	14.4	18.44
45—60	25.6	14.4	19.45
60—75	25.6	14.5	19.31
75—90	26.0	14.8	19.66
0—90			115.78
	Maize — 1949 (Roubeid)		
0—15	27.6	13.3	23.81
15—35	25.6	13.1	29.51
35—55	25.0	13.0	28.56
55—75	25.0	13.0	28.80
75—95	25.2	13.1	29.04
0—95			139.72

* 1 m^3 per dunam = 1 mm rain.

INVESTIGATIONS IN BANANA PLANTATIONS

Outline of the problem and procedure

Banana growing is largely confined to the tropical regions of the world with a yearly rainfall of 1000 to 4000 mm. The plantations are irrigated only in those areas in which rainless periods of some length occur (Taylor 1931; Summerville 1944). Popenoe (1941) and Baeyens (1949) have stressed the exacting requirements of the banana plant, particularly with regard to an ample supply of water.

In Israel, *Musa Cavendishii* Lamb. is the only commercially grown species of banana, about half the total acreage being confined to the Jordan Valley. It is necessary in this country to irrigate banana plantations throughout the long rainless summer which happens to be the period of the most intensive physiological activity of the banana plant.

To the best of our knowledge, no information concerning the irrigation problems of the banana has been published in other countries. Experiments in this field were conducted by the Experiments Committee of the Jordan Valley between 1943 and 1946 (Stoler 1952). It was found that the frequency of irrigation exerts a decisive effect on the yields. A steady and significant decrease in the weight of bunches resulted from the gradual lengthening of the intervals between successive irrigations from 6 to 12 days. The moisture content in the root zone fell towards the end of the longer and shorter irrigation intervals to 50—60 percent and 70 percent of the available water capacity, respectively. Daily evapotranspiration values for banana plantations recorded between May and October averaged 5—8 m^3 per dunam.

The object of the present investigations was to study the physiological behaviour of the banana in relation to soil moisture conditions and to attempt the formulation of a convenient and reliable indicator for the determination of the intervals between successive irrigations.

Following preliminary observations on stomatal opening in both flood- and sprinkler-irrigated plantations, systematic investigations were carried out in 1949 in a two-year-

old sprinkler-irrigated plantation on the Kerak (see Table III). Two plots, A and B, were irrigated at intervals of 5 and 10 days respectively at the rate of 60 m^3 of water per dunam for each irrigation. The daily rate of water supply was 12 m^3 per dunam for plot A, and 6 m^3 per dunam for plot B. During the experimental period of 50 days plot A received eleven irrigations at 5-day intervals; plot B received four irrigations after an interval of 10 days, one irrigation after a 9 -day interval, and one after an 11-day interval. Before and after the experimental period, the irrigation schedule for the whole plantation was based on 5-day intervals.

The response of the banana plant to the reduction of moisture down to permanent wilting percentage was studied on a separate plot in the same plantation. The plot received its last irrigation on May 17, 1950, and the investigations were continued for 75 days until the complete disappearance of available water from the root-zone. Additional tests were carried out in flood-irrigated commercial plantations.

Examination of the root system

With a view to determining the relative exploitation of moisture in different soil layers, a detailed study of the banana root system was carried out in the plantation which had been employed for the main investigation on the response of the banana to changes in soil moisture. The plantation was mulched with straw and did not receive any mechanical cultivation.

Washing with a water-jet into the side of a ditch cut between adjoining rows of plant (in a 265 cm square planting arrangement) disclosed a dense network of roots of varying diameter from 2—3 cm below ground level down to a depth of about 40 cm. Below that level there is a sharp decrease in the number of primary roots, while the number of secondary roots gradually decreases down to 60 cm. The few roots which descend below the 60 cm level are mostly vertical, in contrast with the predominantly horizontal position of the primary roots above the 40 cm level. The vertical roots are confined to the area just underneath the plant, and sometimes reach down to a depth of 70 to 80 cm.

The majority of the primary roots have a diameter of 5 to 10 mm at their base. In addition to fully active, white roots, there are roots with a brown or black surface indicative of various stages of degeneration. With incipient degeneration, the discoloration is confined to the cortex; in more advanced stages the central cylinder also turns brown and, eventually, the whole root may become more or less disintegrated.

The formation of new leaves by the sucker is accompanied by the growth of both horizontal and vertical roots. Both types reach down to a depth of about 30 cm in plants carrying 13—14 leaves. As the number of leaves reaches 19, the horizontal roots spread within the top 40 cm, and the vertical roots penetrate to a depth of 25—45 cm (Figure 1).

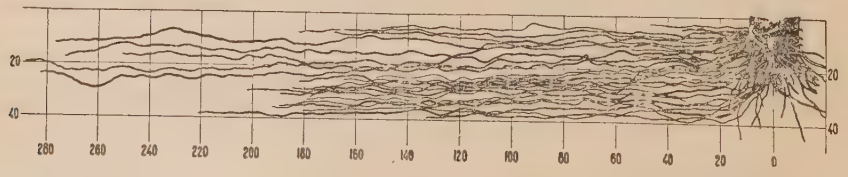

Figure 1
Distribution of primary roots
The diagram shows in one theoretical vertical plane all the primary roots unearthed in a sector of 60 degrees hinged on the base of the plant. The run of each root follows actual position in the soil.

The extent of the root system of fruit-bearing plants resembles that of suckers with 19 leaves, but in the case of the fruit-bearers there is a greater number of degenerate roots in the 20—40 cm layer. The vertical roots of fruit-bearing plants penetrate to a depth of 60—80 cm.

The predominant length of the horizontal roots of fruit-bearing plants ranges between 200 and 330 cm, as against the ranges 180—310 cm and 160—270 cm in suckers with 19 and 14 leaves respectively.

The production of secondary roots is confined to those primary roots which are at least 20 cm long. Two types of secondary roots can be discerned:

A. Roots not exceeding 0.8 mm in diameter and not longer than 15 cm. Such roots densely cover the primary roots, and they start branching off close to their base. They are most abundant in the top 10 cm of the soil, their number decreasing steadily with depth.

B. Roots 0.8—2.7 mm thick and 20—90 cm long, which cover the primary roots less profusely and do not branch for some distance from base. They are most abundant at the depth of 20 to 40 cm. Some of them take an upward turn, while others descend to a depth of 40—60 cm.

In order to determine the relative density of primary roots in different soil layers, blocks of earth measuring 10 × 20 × 20 cm were cut from one side of the ditch. Within each such block, all primary roots with a diameter exceeding 3 mm were counted, active and degenerate roots being recorded separately. Columns C and D in Figure 2 show the primary roots to be most abundant between 20 and 40 cm. The number of active roots (column A) remains almost constant down to a depth of 40 cm, while degenerate roots (column B) are largely confined to the 20—40 cm layer.

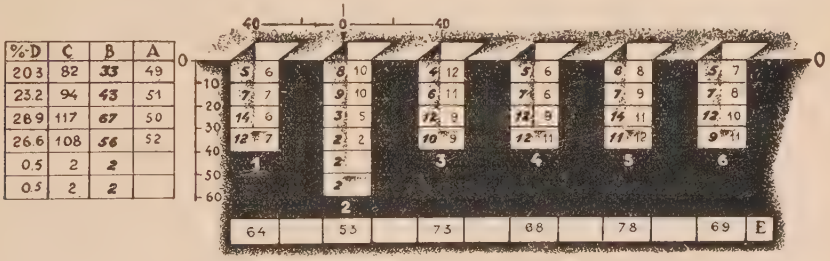

Figure 2

Density of primary roots at different levels.
Schematic representation of results of root examination by blocks.
Figures in blocks: plain — number of active roots; bold — number of degenerate roots.
Figures in summary table: A — active roots; B — degenrate roots; C — all roots; D — percentage of roots in each layer.

It appears that bananas grown on medium soil without tillage and under what had been proven by methods to be discussed later as an optimum irrigation programme, develop a dense root system beginning at a depth of 2 cm and descending rather uniformly down to 40—45 cm. Below this level there is a sharp decrease in the number of roots, while below 60 cm roots are almost completely absent. The presence of a considerable number of roots in the topmost layer of the soil imposes the need for great care in tillage operations.

The root system as described above is typical for *Musa Cavendishii* grown on medium non-compacted soil. It should, however, be borne in mind that the disposition of banana roots varies greatly with the type of soil and the prevailing soil moisture condi-

tions. This is indicated by the studies of Summerville (1939) and Baeyens (1949) as well as by our own observations in commercial plantations in the Jordan Valley and in the Coastal Plain.

Soil moisture and evapotranspiration

The effect of time intervals between successive irrigations on the soil moisture history of the experimental plots is presented graphically in Figure 3. It can be seen that the

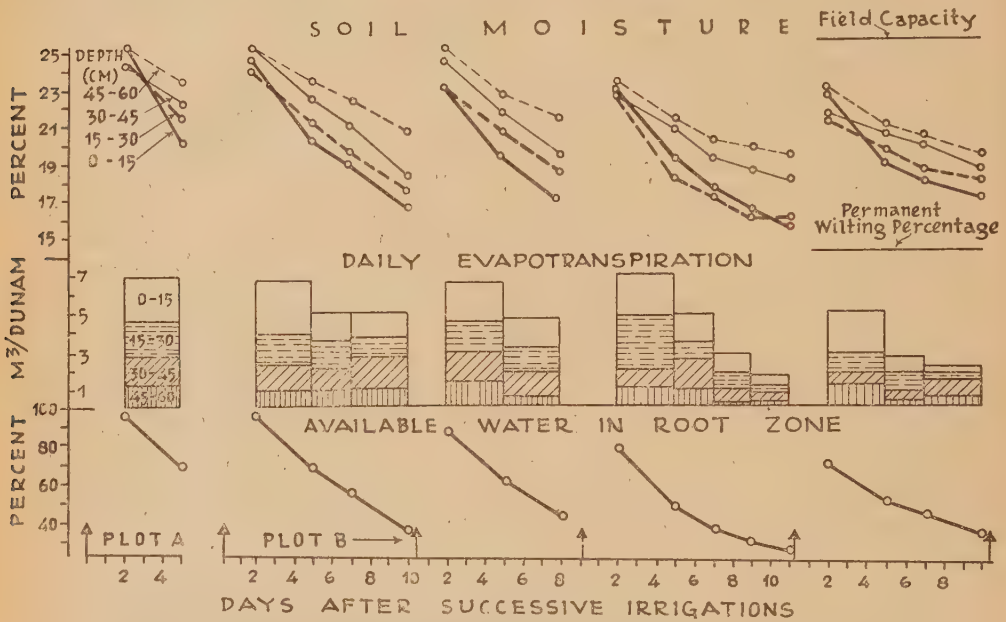

Figure 3

Soil moisture conditions and evapotranspiration
Arrows indicate irrigation at the rate of 60 m³ per dunam.
Values for plot A represent means for 8 successive series of tests, which were almost identical.
Values for plot B refer to tests carried out between 5 successive irrigations

differences in soil moisture content two days after irrigation between plots irrigated at 5-day and longer intervals respectively, gradually increase in the course of the experiment. With irrigation at 5-day intervals at the rate of 12 m³ per dunam, the soil moisture level is maintained during the first two days after irrigation close to field capacity. The daily rate of 6 m³ of water per dunam in overhead application is incapable of making up for the loss of moisture due to evapotranspiration between successive irrigations and during the two days between the last application of water and the examination of soil moisture. This accounts for the consistent reduction of the soil moisture level at the beginning of each successive long interval between irrigations.

The rate of evapotranspiration is largely conditioned by the available water content in the root zone. Evapotranspiration rates in the order of 6 to 7 m³ per dunam, prevail when the soil moisture level is high. When the available water is down to a third of available water capacity, the rate of evapotranspiration amounts to only 2 to 3 m³ per dunam. Under conditions of a high soil moisture content, about 80 percent of moisture lost by evapotranspiration is accounted for by the upper 45 cm, about a third being contributed by the 0—15 cm layer, partly in the form of evaporation. It is evident, however, from the distribution of the roots that even in this top layer transpiration

constitutes the main factor in the depletion of moisture. In the deeper layers, the loss of moisture is almost exclusively due to transpiration.

The depletion of moisture from below the root zone (60—90 cm layer) between the second and fifth day after irrigation or following rain, was found to be 0.4—0.5 m^3 per dunam per day.

The relative losses of moisture from the different layers undergo a decisive change once the moisture content of the root zone falls below two-thirds and approaches one-half of total available water. Under these conditions, the relative contribution of the top 15 cm is considerably reduced, and thus the 15—60 cm layer becomes increasingly responsible for the loss of water from the root zone. The evapotranspiration from all the layers of the root zone becomes very much reduced when soil moisture is down to one-third of available capacity.

Under the more generous irrigation schedule, the soil moisture level did not descend below two-thirds of available water capacity. The lengthening of irrigation intervals resulted in a depletion of soil moisture down to one-third of available water capacity. However, the permanent wilting percentage was not reached in any soil layer even in this extreme case.

In the wilting plot, moisture in the top 15 cm of soil dropped to the permanent wilting percentage 20 days after irrigation. In the 15—30 cm, 30—45 cm, and 45—60 cm layers, the permanent wilting percentage was reached 30, 40, and 75 days after irrigation, respectively.

General observations on the behaviour of banana plants in relation to soil moisture

The rate of unfolding of new leaves in the wilting plot was not affected by the moisture conditions of the root zone as long as it retained not less than 10 percent of the available water. One leaf per plant unfolded, on the average, every 8 days. When soil moisture fell below 10 percent of available water, the intervals increased sharply to as many as 30 days.

The diameter of the pseudostem at 20 cm above ground, as represented by the means of fifty suckers with the same number of leaves (i.e. of same age), attained 57.6 cm in plants irrigated for 50 days at 5-day intervals (plot A) as against 53.8 cm in comparable plants irrigated during the same period at 10-day intervals (plot B). The difference is highly significant, 1.75 being required for significance at $P = 0.01$.

Depletion of soil moisture below a third of available water capacity is accompanied by a marked yellowing of the leaves.

As long as the moisture content of the root zone is maintained above a third of total available water, the folds of all the young leaves invariably contain water during morning and midday. When soil moisture drops below about 30 percent, water can be found in small quantites only in the funnel-shaped cavity formed by the youngest unrolling leaves and, even there, its occurrence is confined to morning hours. Such water accumulations must therefore be, at least partially, the result of active secretion by the plant, the rate of secretion depending on soil moisture conditions.

Opening of stomata

The degree of stomatal opening was tested by infiltration with kerosene and by means of the collodion film method. It had been shown in preliminary tests that the third fully

expanded leaf, counting from the top (to be designated subsequently as "the third leaf"), is most responsive on account of being the youngest leaf with fully mature stomata. In view of the marked differences in the density of stomata in different portions of the leaf, the position for the application of the test was fixed, as indicated in Figure 4, to ensure similar density of stomata for leaves of the same age. The scale given in Table I was employed for the evaluation of infiltration data.

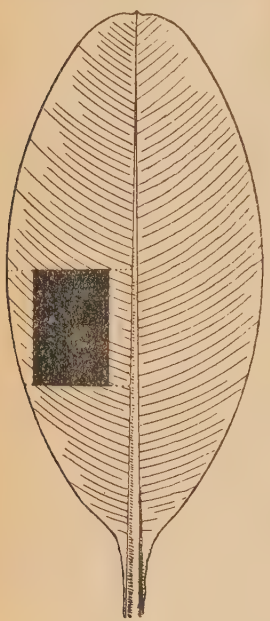

Figure 4

Schematic representation of the third fully developed leaf counting from top. The black rectangle indicates portion used in stomatal opening tests; dotted lines enclose the section which provided material for determinations of transpiration, dry matter, water content, and osmotic pressure.

It has been found that the density of stomata on the upper and lower surface of the leaves, respectively, depends to some extent on the method of irrigation. Consequently, the relative infiltration rates of the two leaf surfaces differ between flood-irrigated plantations and those receiving overhead irrigation.

Investigations in a sprinkler-irrigated plantation. Diurnal changes in the state of stomatal opening were investigated on 25 days during an experimental period of 50 days. Each test was repeated in two plots irrigated at 5- and 10-day intervals respectively. A concise summary of the infiltration data is given in Table IV.

TABLE IV

Leaf infiltration values in relation to percentage of available water in the root zone

Mean daily infiltration values recorded between 7.00 and 16.00 on leaves exposed to sunlight in a sprinkler-irrigated plantation (each value represents the average of 2 to 4 days).

Frequency of irrigation	Every 5 days				Every 10 days		
Days after irrigation	1	3	4	5	6—7	9	7—9
% available water	>100	86	77	67	55	43	34
Infiltration on upper surface of leaf	92	85	94	64	64	59	25
Infiltration on under surface of leaf	87	79	72	43	41	44	21
Infiltration average for both surfaces	90	82	83	53	52	52	23

A definite relationship exists between the maximum and the mean daily infiltration values in leaves exposed to sunlight, and the amount of available soil water. During the first four days following irrigation, there is a slight decrease in the daily mean, while the available moisture drops to 77 percent. Subsequently, the diminution of the mean infiltration values becomes much more pronounced.

The diurnal changes in stomatal opening are also markedly affected by the amount

of available root zone water. As long as soil moisture content remains at a high level (the first four days after irrigation) the daily infiltration curves resemble each other with regard to the level and the time of occurrence of infiltration values, from both leaf surfaces and during most of the day (Figures 5, 6 and 8). Maximum stomatal aperture is maintained from early morning till afternoon and gradual closure sets in some hours before sunset.

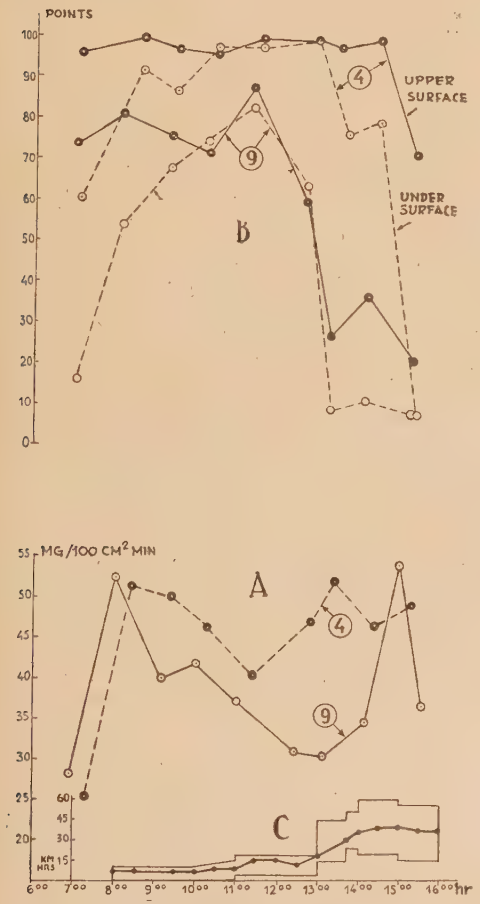

Figure 5
Diurnal variations in transpiration (A), infiltration (B) and wind velocity (C)
Figures in circles denote number of days after irrigation. The tests were performed on July 8, 1949, with leaves exposed to sunlight in an overhead-irrigated plantation.

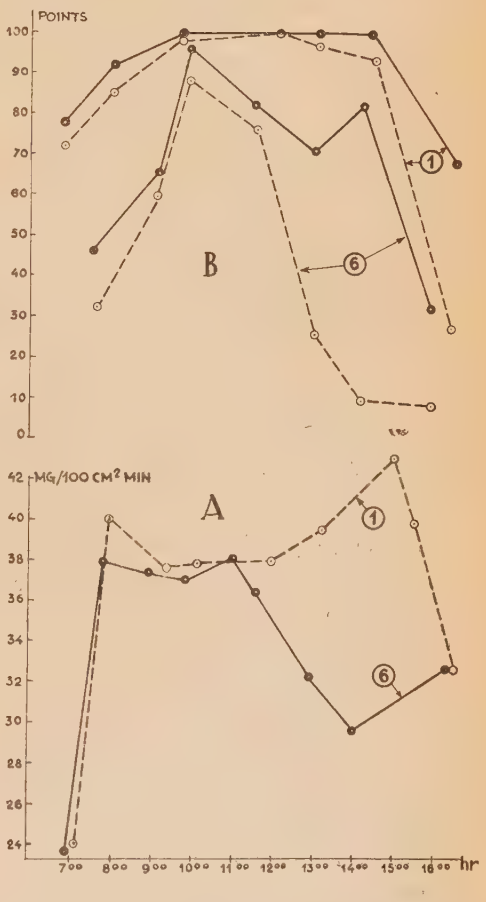

Figure 6
Diurnal variations in transpiration (A) and infiltration (B)
Figures in circles denote number of days after irrigation. The tests were performed on July 26, 1949, with leaves exposed to sunlight in an overhead-irrigated plantation.

When the soil moisture content ranges around one-third of total available water, opening of stomata is very much restricted. The curves representing stomatal opening show one low peak during the early morning hours, and this is followed by gradual diminution of stomatal aperture. There is little variation in the rate of infiltration during most hours of the day and there is little difference between the infiltration rates of the two leaf surfaces (Figures 7 and 8).

In the intermediate range of soil moisture — approximately from two-thirds down to

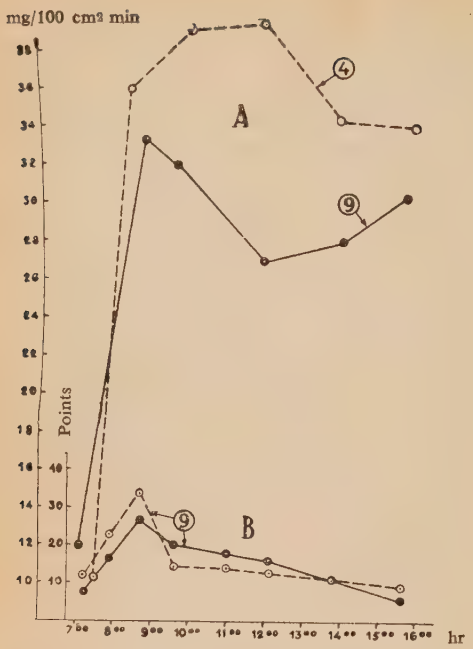

Figure 7
Diurnal variations in transpiration (A) and infiltration (B)
Figures in circles denote number of days after irrigation. Tests were performed on August 18, 1949, with leaves exposed to sunlight in an overhead-irrigated plantation.

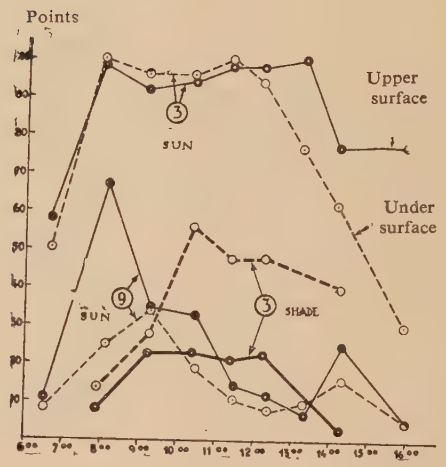

Figure 8
Diurnal variations in infiltration into shaded and unshaded leaves
Figures in circles denote number of days after irrigation. Tests were performed on August 7, 1949, in an overhead-irrigated plantation.

one-third of total available water — there is a gradual reduction of infiltration values down the scale between the high and the low moisture status. The progressive restriction of stomatal opening in relation to decreasing root zone moisture finds expression in the following diurnal behaviour:

(a) Maximum infiltration values of 80 to 100 points are confined for both leaf surfaces to morning hours.

(b) A reduction in infiltration values sets in about noon or even earlier, the reduction being usually more pronounced on the under-surfaces of leaves.

(c) The infiltration curves for the two leaf surfaces are not parallel, the divergence being more marked for the range of root zone moisture, i.e. around 60 percent of total available water (note sixth day in Figure 6).

The diurnal changes in the state of stomatal opening give expression to the sensitivity of the banana plant to reduction in the amount of available water. Opening of the stomata to maximum extent during most of the day is confined to a narrow range of soil moisture whose lower limit is approximately two-thirds of total available water. When available moisture diminishes progressively below this level, the banana plant encounters increasing difficulties in maintaining its water balance. This difficulty is reflected in a reduction of the maximum extent of stomatal opening and its confinement to the morning hours. The impairment of the water balance becomes acute when the moisture content of the root zone drops to about a third of the total available water.

Investigations in flood-irrigated plantations. Infiltration data for one day, which can be considered as representative of flood-irrigated commercial plantations on the Roubeid type of soil (see Table III), are given in Figure 9.

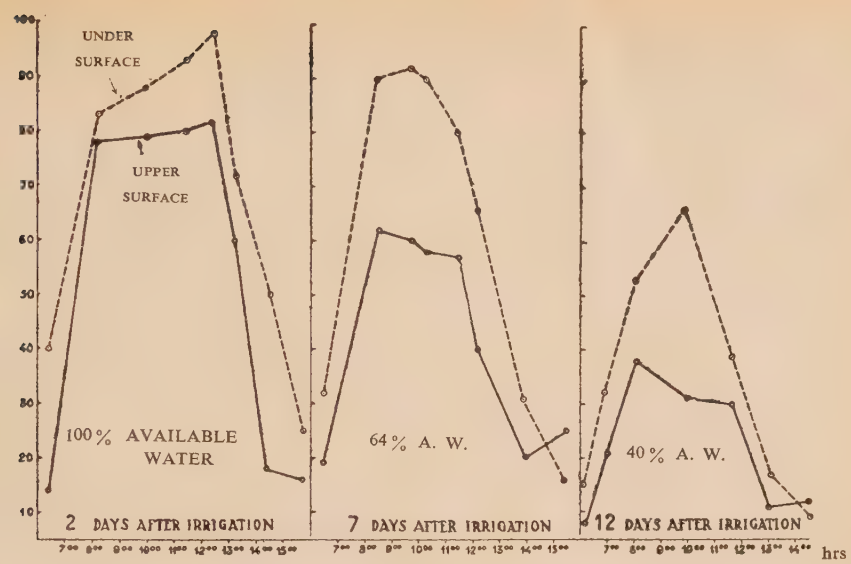

Figure 9
Diurnal variations in infiltration
Tests were performed on July 12, 1950, in a flood-irrigated plantation.

A striking difference between flooded and overhead irrigated plantations consists in the fact that in the former infiltration is more rapid on the lower side of leaves exposed to sunlight, while in the latter the higher rate of infiltration is associated with the upper side of unshaded leaves.

Under similar conditions of root zone moisture, rates of infiltration are generally somewhat lower in the flood-irrigated plantations, particularly in the higher range of soil moisture (compare Figures 9 and 5 to 8).

The correlation between infiltration values and soil moisture in flood-irrigated plantations follows closely the trends described for overhead-irrigated plantations.

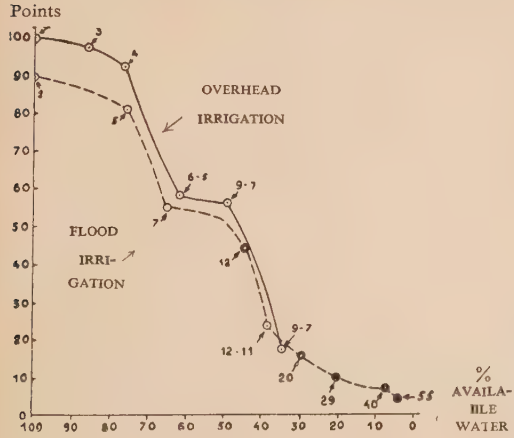

Figure 10
Relation between the rates of infiltration and available water under different irrigation methods
The values represent means of tests performed between the hours 12.00 and 13.00, with leaves exposed to sunlight. Circles with bold outline refer to values recorded in the wilting plot. Figures with arrows denote number of days after irrigation.

Infiltration tests as a guide to irrigation. Comparison of diurnal changes in the rate of infiltration as recorded in the third leaf exposed to sunlight shows that, irrespective of the method of irrigation, the relationship between the rate of infiltration and the soil moisture content is conspicuously reflected in the results of tests performed between the hours 12.00 and 13.00. It can be seen in Figure 10 that the diminution of soil moisture from about 80 percent to two-thirds of total available water is associated with a decrease of approximately 40 percent in the rates of infiltration recorded during the first hours of the afternoon. Such conspicuous decrease in infiltration rate should be re-

garded as a warning that the reserve of readily available water in the root zone is in need of repletion and irrigation should be applied without delay.

It is clear from the above account that examination of the state of stomatal opening in leaves exposed to sunlight provides a reliable indicator of soil moisture conditions and makes it possible to determine the need for renewal of irrigation.

Stomatal opening was also investigated in banana leaves subjected to the shade of other leaves and under conditions of an overcast sky. In shaded leaves, irrespective of the method of irrigation, the rate of infiltration is higher on the under-surfaces compared with the upper surfaces, in contrast to the relative infiltration rates prevailing on the two sides of leaves exposed to sunlight, as recorded in plantations receiving overhead irrigation. The daily infiltration curve of shaded leaves has normally one peak (Figure 8). It appears that, under comparable soil moisture conditions, infiltration values of shaded leaves are two to three times lower than those of leaves exposed to sunlight. Definite dependence of the extent of stomatal opening on soil moisture conditions is also apparent in shaded leaves, but the changes are less pronounced than in the case of leaves fully exposed to sunlight. It is therefore inadvisable to carry out indicatory examinations for the determination of irrigation requirements on shaded leaves or during cloudy weather. Fortunately, during the irrigation season, the number of cloudy days is very small in this country and there is no difficulty in selecting adequately illuminated leaves for the indicatory tests.

Practical recommendations based on these findings (Shmueli 1952) have already proved their value during the last three years in field application by banana growers of the Jordan Valley and the Coastal Plain.

Transpiration

All the investigations on the transpiration were carried out in a plantation receiving overhead irrigation. Examinations were based on leaf sections measuring 50 cm² taken from a fixed portion of the leaf indicated in Figure 4. Table V summarizes the prin-

TABLE V

Transpiration in relation to climatic factors and available water

Date of test	8.VII.		16.VII.		26.VII.		5.VIII.		8.VIII.		18.VIII.	
Max. temp. (°C)	34		34		34		36		37		33	
Time of max. temp.	13.30		14.30		15.00		14.00		14.30		14.00	
Min. rel. humidity (%)	28		40		39		40		30		40	
Time of min. rel. humidity	13.30		14.30		14.00		15.15		14.00		15.00	
Starting time of wind up to 25 km/hr			13.00		12.00							
Starting time of wind up to 40 km/hr	13.00						13.00		14.00		14.00	
Starting time of wind up to 60 km/hr	14.00						15.00		16.00		15.00	
Days after irrigation	4	9	1	6	1	6	1	7	4	10	4	9
Available water in root zone (%)	77	43	> 100	62	> 100	56	> 100	37	77	28	77	37
Daily maximum (or maxima) of transpiration (mg/100 cm².min)	51 52 8151325	52 54 7501435	40 54 9051 5	38 7551	40 43 7551 5	38 7401 1	46 33 1055 930	34 1515	38 38 9501430	32 35 9101 5	39 33 12 8501535	30
Time of maximum (or maxima)	40	30	35		38		28		29	25	27	
Min. transpiration at about noon (mg/100 cm² min)												
Percentage comparison between daily means of transpiration in relation to length of interval after irrigation (value referring to shorter interval = 100).	100	85	100	84	100	88	100	81	100	72	100	82

cipal transpiration data which were concurrently recorded on plants supplied with different quantities of available water. The diurnal changes in the rate of transpiration are illustrated in Figures 5, 6 and 7.

Soil moisture and transpiration. The daily mean of transpiration is considerably higher in plants supplied with more than two-thirds of total available water than in plants with a less adequate supply of moisture. The daily maximum and the minimum midday level of transpiration of the former are also higher, as a rule, than the latter. Moreover, the reduction in the transpiration rate is more marked and occurs earlier in the day in plants supplied with less than two-thirds of total available water. Soil moisture thus exerts a very pronounced effect on the transpiration level. It is clear that the banana plant is incapable of exploiting small amounts of available water with the same efficiency as large amounts. There is no doubt that the decrease in the rate of evapotranspiration associated with reduction in available water is at least partly due to reduced transpiration.

Diurnal changes in transpiration. The daily course of transpiration does not run parallel with the fluctuations in climatic factors. The rate of transpiration reaches the daily peak — or, more frequently, the first of two daily peaks — already in the morning or around noon, whereupon it decreases in the afternoon. When temperature, relative humidity and the west wind attain their extreme values, there is mostly another rise in transpiration rate, which lasts to second peak.

Among the factors affecting transpiration, wind velocity appears to exert the most pronounced effect. Plants supplied with less than two thirds of available water, arrive at the second transpiration peak in the afternoon only when wind velocity goes up to 40—60 km per hour (Table V, Figures 5 and 7). In plants enjoying a more plentiful supply of available water, an increase in transpiration rate can be brought about by wind velocities not exceeding 25 km (Table V, Figure 6). It is therefore not surprising that the banana plant, with its large leaves, responds readily to efficient protection from wind. It can be assumed that the higher yields obtainable from rows of bananas adjacent to windbreaks (Stoler 1926, Siev 1952) are the result of a more favourable water balance of the plants concerned.

Transpiration in relation to stomatal opening. The rate of transpiration and the degree of stomatal opening were determined in parallel tests carried out at intervals of 2—20 minutes on corresponding parts of the leaves (see Figure 4).

Comparison of transpiration and infiltration data (Figures 5, 6 and 7) shows that stomatal opening does not constitute the main factor affecting the rates and the daily progress of transpiration. It should be noted, for instance, that, under conditions prevailing in the Jordan Valley, transpiration may reach considerable values at a time when stomatal apertures are only between 0—2 microns (see curve for 9th day after irrigation, Figure 7).

Whereas stomatal opening in leaves exposed to sunlight is decisively conditioned by the amount of available water, the rate of transpiration is also considerably affected by weather conditions. It is, therefore, evident that the diurnal changes in stomatal opening provide a more reliable indication of the water balance of banana than the diurnal course of transpiration.

Dry matter and water content of leaves in relation to soil moisture

Changes in weight were determined in samples of leaf-blade measuring 50 cm^2, taken from the leaf section which had been fixed for infiltration and transpiration tests (see

Figure 4). Fresh and dry weight was determined for each sample and water content was computed against dry weight. All determinations were made between 7.00 a.m. and 3.00 p.m.

Dry matter. A definite trend is noticeable from the high level of dry matter content associated with soil-moisture above two-thirds of total available water, through the rapidly diminishing dry weight values recorded at increasing intervals after irrigation, under conditions of progressively decreasing content of available water (Figure 11).

Days after irrigation	1—4	6—10
Mean dry matter content per 100 cm² of leaf-blade (mg)	923	828
Sign. diff. 0.01	46.08	

The differences between the dry weights obtained when soil-moisture values were above two-thirds and around one-third of total available water, respectively, are highly significant.

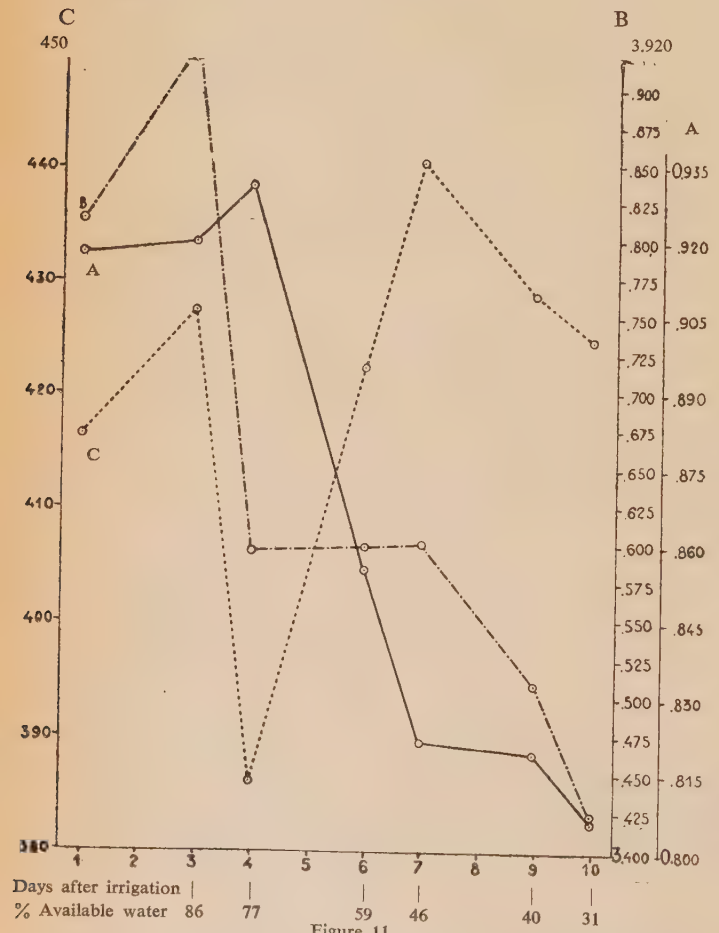

Figure 11

Daily means of dry matter and water content per 100 cm² of leaf in relation to available root zone water.

(A) g dry matter, (B) g water content, (C) Percent water content computed against dry weight.

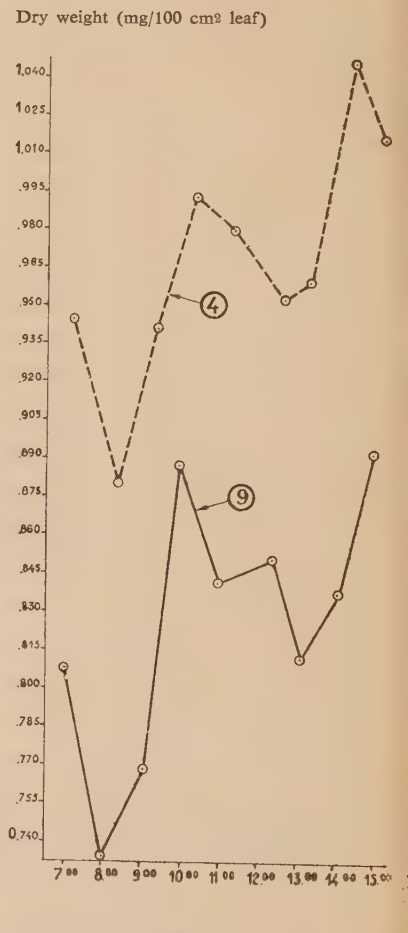

Figure 12

Diurnal variations in dry matter content of leaves

Figures in circles denote number of days after irrigation. Determinations were made on July 8, 1949.

Higher values for dry matter content in leaves were obtained at all hours in plants irrigated 4 days prior to examination, compared with those which had been irrigated 9 days in advance of examination (Figure 12). The daily mean of dry weight was also higher in the former compared with the latter, the difference being highly significant.

Days after irrigation	4	9
Mean dry matter content per 100 cm² of leaf-blade (mg)	965	826
Sign. diff. 0.01	47.52	

Water content of leaves. Whereas the dry matter content of leaves does not show a conspicuous reduction as long as soil moisture in the root zone remains above two-thirds of total available water, a marked decrease in the water content of the leaves can be observed when the soil moisture level is still about three-fourths of total available water (Figure 11). No significance is being ascribed to the rise in water content recorded for the third day of the irrigation interval, as it represents only one day of sampling, while the remaining values are averages of data obtained on two or three different days. The reduction in soil moisture from two-thirds to about one-half of total available water is not connected with a reduction in the water content of the leaves; but as the process of soil desiccation continues down to one-third of total available water, a further reduction in the water content of the leaves takes place. The differences between the three levels of water content in leaves are significant.

Days after irrigation	1—3	4—7	9—10
Water content of 100 cm² of leaf-blade (mg)	3845	3603	3481
Sign. diff. 0.05	228	101	

At all levels of available soil moisture, the water content of leaves went down in the course of the day from morning to afternoon. When the soil moisture content was less than two-thirds of total available water, the water content of leaves was lower at all hours of the day compared with that recorded under conditions of soil moisture approaching field capacity (Table VI). The daily average of water content in leaves was significantly higher on the first day compared with the sixth day after irrigation.

TABLE VI

Diurnal variations in the water content of leaves in relation to available water in root zone

Data represent means of values recorded on July 16th and 26th, 1949.

Days after irrigation	1	6
Percentage of available water	>100	59
Hour	Water content per 100 cm² of leaf (mg)	
7.00—8.00	3972	3700
8.00—9.00	3959	3621
9.00—10.00	3946	3547
10.00—11.00	3938	3737
11.00—12.00	3905	3446
12.00—13.00	3915	3631
13.00—14.00	3898	3598
14.00—15.00	3802	3515
Daily mean	3917	3598
Sign. diff. 0.01	113	

Relative water content of leaves as affected by soil moisture. The values in curve C, Figure 11, represent mean daily values of water content compared as percentages of corresponding dry weights. The marked depression on the fourth day after irrigation can be accounted for by considerable reduction in the water content of the leaves at the time when dry matter content is still maintained at a high level. This minimum value of relative water content is significantly lower compared with adjoining daily values.

Days after irrigation	1—3	4	6—7
Water content of leaves (% dry weight)	419.6	385.7	431.3
Sign. diff. 0.01		30.4	49.6

In view of the absence of consistent correlation between available soil moisture and the relative water content of the leaf, the latter cannot be recommended for use as an indicator for irrigation requirements.

Osmotic pressure

The osmotic pressure was determined in the first and third leaves from the top, using a fixed portion of the leaf (see Figure 4), and in primary roots.

Relation between osmotic pressure, water content of leaves and soil moisture conditions. The osmotic values of both leaves amd roots are relatively low. They range from 4.70 to 9.75 atmospheres in the roots, from 8.44 to 12.64 atm. in the youngest fully expanded leaf, and from 9.27 to 13.42 atm. in the third leaf from the top. The range of fluctuation is thus smaller in leaves than in roots.

The osmotic pressure rises generally from morning till afternoon. This diurnal rise is particularly marked in plants which have at their disposal about two-thirds of total available water (Table VII).

TABLE VII

Diurnal variations in osmotic pressure of leaves and roots in relation to available water in root zone

Part of plant	Root		Third leaf from top		
Days after irrigation	7	12	2	5	11
Available water	64%	40%	100%	76%	44 %
6.15— 7.30	4.70	5.42	9.51	9.64	9.27
7.35— 9.45	5.30	6.39	9.63	9.64	9.78
10.40—11.30	6.02	6.99	10.96	10.24	9.88
12.00—13.40	6.75	7.23	10.24	10.24	9.75
14.00—15.20	6.87	6.87	10.24	13.28	9.99
15.25—16.00	7.11	6.75			
16.15—17.00			10.60	13.12	10.60

The difference in the levels of osmotic pressure between leaves and roots decreases with the reduction in soil moisture content. A number of determinations carried out before noon produced the following differences between the osmotic pressure of leaves

and that of roots, in relation to soil moisture. For soil-moisture values of 77, 64, 40, and 28 percent of total available water, the differences in osmotic pressure were 6.41, 5.17, 4.33 and 2.29 atm., respectively. The downward trend of the differences is due to an increase in the osmotic pressure of the roots, while in the leaves a certain reduction in osmotic pressure actually occurs when soil moisture drops below 50 percent to available water. The reduction in the osmotic values of the roots due to the decrease of soil moisture below 50 percent of total available water is statistically significant.

% available water	Above 50	Below 50
Osmotic pressure (atm)	6.40	7.80
Sign. diff. 0.05	1.20	

The difference between the average osmotic values of the third leaf as obtained under conditions of available soil moisture above and below 50 percent of available water, respectively, amounted to 0.69 atmospheres. Although this difference does not attain statistical significance, it does not appear to be accidental. It should be noted that the highest osmotic values were invariably recorded when soil moisture was around 75 percent of total available water. Diminution in the amount of available water was associated with relatively low osmotic values, particularly in the afternoon. The lowest values of osmotic pressure were recorded in the wilting plot when soil moisture was down to only 7.5 percent of total available water.

It is likely that the unexpected changes in osmotic pressure connected with the digging up of the soil are brought about by the increase in the relative water content of the leaves (Figure 11). It should be noted that the highest values of osmotic pressure were obtained when the relative water content of the leaves was at the lowest level. The reduction of osmotic pressure under conditions of decreasing soil moisture coincides with the rise in the water percentage of the leaves.

Physiological responses of the banana plant to reduction in soil moisture

The banana plant is very sensitive to moisture conditions in the root zone and its physiological activity remains undisturbed only within a narrow range of available root zone water. When soil moisture content diminishes progressively from just above two-thirds of total available water, the plant encounters increasing difficulty in maintaining its water balance. This disturbed physiological condition is reflected first of all in the reduction of the water content of the leaves (Figure 11). The resulting reduction in turgor brings about a restriction in the opening of stomata (Figure 10). Further reduction takes place in the dry matter content of the leaves (Figure 11) and in the transpiration rate (Table V).

With reduction of soil-moisture to less than half of the total available water there is a rise in the osmotic pressure of the roots. In the leaves, on the other hand, such low soil moisture level results in a reduction of osmotic pressure. Minimum values of osmotic pressure in leaves are recorded when soil moisture is down to a state approaching complete depletion of available water. The general trend of fluctuations in osmotic pressure of the banana resembles that of succulent desert plants (Tadros 1936, Migahid

1937). Similar changes in osmotic pressure are reported by Walter (1950) in wild plants which become chlorotic as a result of soil dryness. These plants respond to conditions of diminishing soil moisture by closure of stomata, reduced assimilation and accelerated decomposition of proteins indicative of a state of starvation. It is noteworthy that yellowing occurs also in banana leaves when soil moisture falls below one-third of total available water. It is very likely that these chlorotic symptoms are also indicative of starvation conditions. The marked restriction of stomatal opening in the banana, which begins already when the soil moisture level drops below two-thirds of available capacity, seems to constitute a major factor in the restriction of assimilatory activity. The latter finds expression in the reduction of the dry matter content of the leaves.

The changes in the dry matter content of the leaves shed light on the problem of the reduction of yields which is brought about by the lengthening of intervals between successive irrigations. In this connection, it is interesting to relate the variation in the dry matter content of leaves with the yields recorded in irrigation experiments carried out in the Jordan Valley on a somewhat heavier soil than in our experimental plots (Stoler 1952) — the increase in yields recorded by Stoler as a result of shortening the irrigation intervals from 12 to 6 days was 13 to 17 percent. A similar difference is obtained by comparing the dry matter content of leaves 4 and 10 days after irrigation.

It may be concluded that in the conditions of the Jordan Valley, the range between field capacity and two-thirds of total available water constitutes the optimum range of soil moisture for the Cavendish banana, with regard to physiological activity and yields. It appears that only within this range, soil moisture in the root zone is readily available and that only within its limits can the plant fully exercise its physiological functions, as far as they depend on the supply of water.

Between successive applications of water, the moisture content of the root zone is liable to drop below the optimum range. The longer the duration of the sub-optimal conditions, the greater the loss in the accumulation of assimilation products. Owing to the sensitive response of the stomata to variations in soil moisture, infiltration tests provide a convenient and reliable indicator for fixing the correct intervals between irrigations.

REFERENCES

1. Baeyens, J., 1949, Classifying banana soils in tropical West Africa, *Tech. Commun. Bur. Soil Sci.*, Harpenden, **46**, 203—209.
2. Buscalioni, L. and Pollacci, G., 1902, L'applicazione delle pellicole di collodio allo studio di alcuni processi fisiologici nelle piante ad in particular modo alla transpirazione, *Atti Ist. bot. Univ. Pavia*, **2**, 83—95; 127—170.
3. Huber, B., 1927, Zur Methodik der Transpirationsbestimmung am Standort, *Ber. dtsch. bot. Ges.*, **45**, 611—618.
4. Lloyd, F. E., 1908, The physiology of stomata, *Publ. Carneg. Instn.*, **82**, 1—142.
5. Lorch, J., 1951, Observations on windbreaks in banana plantations of the Jordan Valley (in Hebrew), *M. Sc. Thesis, Hebrew University*, Rehovot.
6. Migahid, A. M., 1937, The water economy and the development of *Kalanchoe aegyptiaca*, under different conditions of soil moisture, *Bull. Fac. Sci. Egypt. Univ.*, No. 8.
7. Molisch, H., 1912, Das Offen- und Geschlossensein der Spaltoeffnungen, veranschaulicht durch eine neue Methode, *Z. Bot.*, **4**, 106—122.
8. Oppenheimer, H. R. and Elze, D. L., 1941, Irrigation of citrus trees according to physiological indicators, *Palest. J. Bot.*, Rehovot, **4**, 20—46.
9. Oppenheimer, H. R. and Mendel, K., 1939, Orange leaf transpiration under orchard conditions, *Bull. agric. Exp. Sta.*, Rehovot, pp. 82.
10. Popenoe, W., 1941, Banana culture around the Caribbean, *Trop. Agr. Trin.*, **18**, 8—12, 33—38.
11. Shmueli, E., 1952, Response of banana to reduction of soil moisture, *Studies on Banana* (in Hebrew), Tel Aviv.

12. Siev, D., 1952, Comparison between two types of windbreaks (in Hebrew), *Studies on Banana*, Tel Aviv.
13. Stalfelt, M. G., 1929, Neuere Methoden zur Ermittlung des Oeffnungszustandes der Stomata, *Handb. biol. Arb. Meth.*, 167—192.
14. Stoler, S., 1926, Banana growing in Israel (in Hebrew), *Hassadeh*, **6**, 248, 307.
15. Stoler, S., 1952, Experiments on the irrigation of banana (in Hebrew), *Studies on Banana*, Tel Aviv.
16. Summerville, W. A. T., 1939, Root distribution of the Banana, *Qd. agric. y.*, **52**, 376—392.
17. Summerville, W. A. T., 1944, Studies on nutrition as qualified by development in *Musa Cavendishii* Lamb., *Qd. Y. agric. Sci.*, **1**, 1—127.
18. Tadros, T. M., 1936, The osmotic pressure of Egyptian desert plants, *Bull. Fac. Sci. Egypt. Univ.*, No. 7.
19. Taylor, G., 1931, Settlement Zones of the Sierra Nevada de Santa Marta Columbia, *Geogr. Rev.*, Oct.
20. Veihmeyer, F. Y. and Hendrickson, A. H., 1949, Methods of measuring field capacity and permanent wilting percentage of soils, *Soil. Sci.*, **68**, 75—94.
21. Walter, H., 1931, *Die Hydratur der Pflanze*, Jena.
22. Walter, H., 1950, *Grundlagen des Pflanzenlebens*, Stuttgart.

LETTERS TO THE EDITOR

The Editorial Board does not accept responsibility for the views expressed in the letters printed below

Further Identification of the Sugars Present in Lettuce Seeds

In a previous paper, changes in the amount of sugars of lettuce seeds during germination and its inhibition were reported[1]. The sugars present were identified as glucose and sucrose. A further attempt was made to establish their identity with aid of paper chromatography.

Water extracts of dry lettuce seeds and seedlings were used. Whatman No. 1 paper was employed. The ascending method was adapted, using the solvents ethyl acetate — acetic acid — water (3:1:3) and *n*-butanol — ethanol — water (10:1:2). The chromatograms were developed by spraying with the double spray of benzidine and iodine[2], orcinol[3] and *p*-amino hippuric acid[4].

Only two sugars were found in the extracts, which were identified as glucose and sucrose. Fructose appeared only in hydrolyzed extracts as a product of hydrolysis of sucrose. It was never found as a free natural constituent of lettuce seeds or seedlings up to the age of 96 hours.

I am indebted to Dr. E. Ben-Gershom for his help and advice during this work.

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REFERENCES

1. Poljakoff-Mayber, A., 1952, *Pal. J. Bot. J Series*, 5, 180.
2. Ben-Gershom, E., 1953, *The mechanisms of the enzymatic hydrolysis of cyclodextrin and maltose*, Thesis for Ph. D., The Hebrew University of Jerusalem.
3. Bevenue, A. and Williams, K. T., 1951, *Arch. Bioch. Biophys.*, 34, 225.
4. Sattler, L. and Zerban, F. W., 1952, *Anal. Chem.*, 24, 1862.

Received September 20, 1953.

X-ray Investigations of the Thermal Decomposition of Potassium Perchlorate in vacuo

In a previous communication it was asserted[1] that the X-ray diffraction picture of a sample of potassium perchlorate which had been partially decomposed into potassium chloride and chlorate by heating in vacuo, was qualitatively different from that of a mechanical mixture of the three salts in the same ratio.

As this phenomenon would indicate that the perchlorate lattice, on losing oxygen, would persist for a measurable time before changing into the lattice of potassium chloride, a quantitative study was undertaken.

X-ray powder photographs were carried out in a cylindrical camera of 30 mm radius, with Cuα radiation at 44—45 kV, the powdered sample being contained in a beryllium glass capillary. The following samples were studied: potassium chloride, chlorate, and perchlorate; potassium perchlorate heated at 600°C in vacuo for various lengths of time (10, 18, 25, 35, 45, and 60 minutes); and finely (better than 200 mesh) ground mechanical mixtures of the same chemical composition as the samples obtained by the thermal decomposition.

The photographic negatives were evaluated with the help of a Kipp Photometer.

Results. In accordance with the previous observations, the lines characteristic of potassium chloride do not appear in partially decomposed perchlorate up to a chloride content of 15% KCl (10 and 18 minutes heating time), and become conspicuous only after 25 minutes heating at 600°C (37% chloride). On the other hand the lines of perchlorate fade out gradually with the progress of decomposition. Certain lines, e.g. (103), disappear when only 10% of the perchlorate are decomposed (after 10 minutes); others persist till after 60 minutes heating time (about 18% $KClO_4$).

As the first new crystals of potassium chloride formed are very small, the intensities of the diffraction lines will be influenced by particle size and this may account for the small differences found between the "thermal" and the mechanical mixtures of the same chemical composition (Figure 1).

Moreover, if the decomposition reaction of potassium perchlorate takes place inside the original crystals, a shift of its interplanar spacings should appear; but experimentally no shift of the diffraction angles with heating times, and hence no shift of the interplanar spacings could be detected within $\pm$ 0.03 A.

The previous claim can thus not be confirmed*; the X-ray photographs do not permit any decision regarding the persistance of the lattice of potassium chloride and oxygen.

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REFERENCE

1. Simchen, A. E., Glasner, A. and Fraenkel, B., 1951, *Bull. Res. Counc. of Israel*, 2, 70.

Received December 30, 1953.

* The $KClO_4$ used in the previous study was less pure (about 0.5% MgO + 0.5% Ca compounds) than the analytica grade substances used in the present experiments.

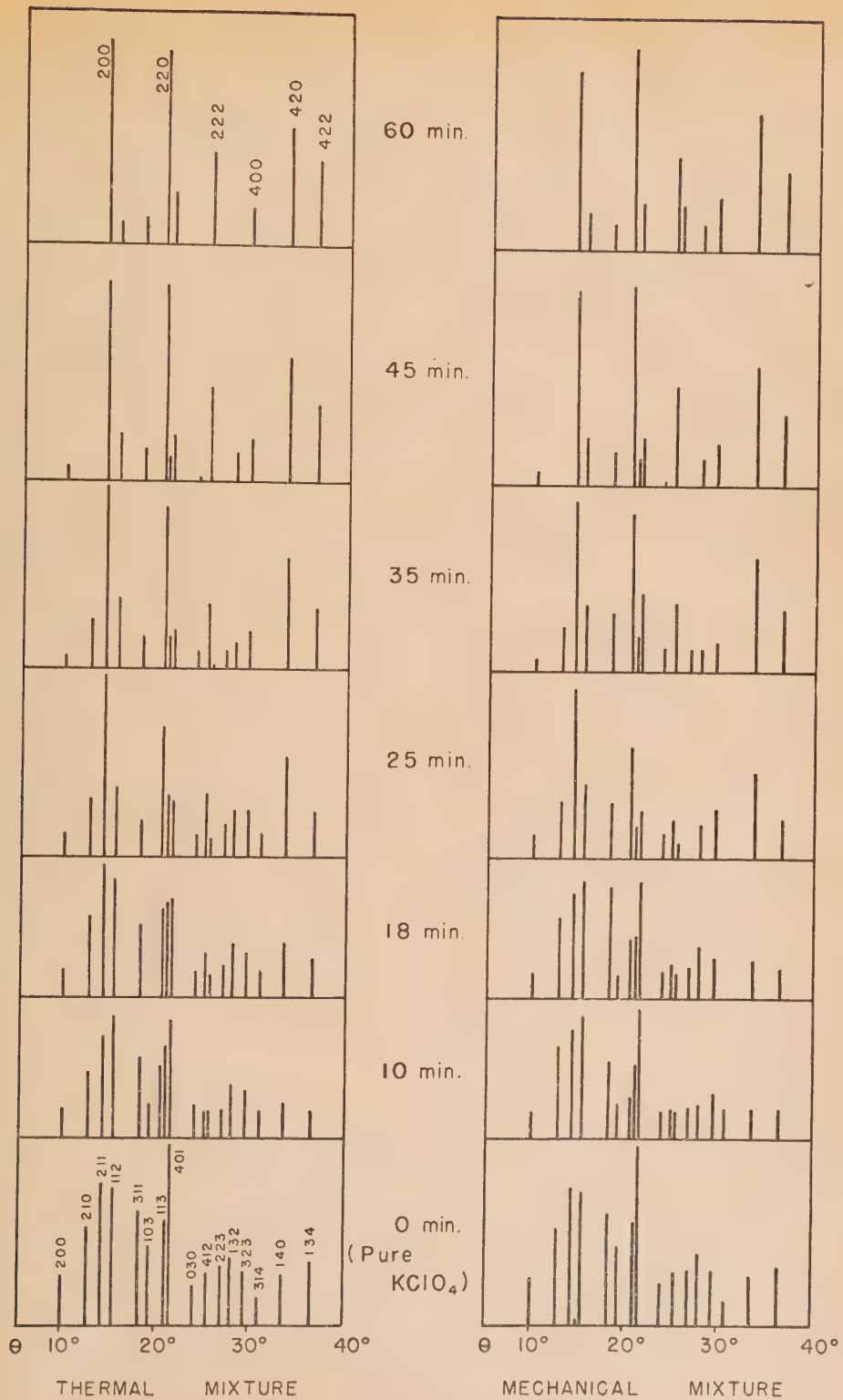

Figure 1

X-ray diffraction pictures of potassium perchlorate heated at 600° C in vacuo for various lengths of time, and of mechanical mixtures of the same chemical composition. The ordinates represent relative photometric heights. The figures on the diffraction lines 0 min. (pure $KClO_4$) corresond to the $KClO_4$ lattice. The figures on the lines at 60 min. correspond to the KCl lattice.

Peat from the Huleh Region in Israel as Ion Exchange Material for Water Softening

In the first practical application of ion exchange for water treatment in 1906 by Ganz[1] natural and artificial hydrated silicates of aluminium and sodium known as zeolite, greensand, glauconite and permutit were used.

Since about 1936 sulfonated coal, lignite and peat[2,3] came into use and were found to possess excellent ion exchange properties. All these substances, known as carbonaceous zeolites, are now produced commercially and widely used in the U.S.A. and Europe[4].

A further interesting development in ion exchange is represented by the manufacture of resins; these synthetic polymers are however much too expensive for commercial use today.

In view of the fact that the water throughout Israel is hard (130—300 ppm $CaCO_3$) and the cost of imported permutit or similar ion exchange materials is prohibitive, experiments were started with a natural material found in very large quantities in our country: peat from the Huleh region.

Preparation of the peat exchanger. Sulfonated peat was prepared in the following manner: 1500 g finely divided peat from the Huleh region, with approx. composition: 60% combustible material, 28% ash and 12% humidity, were treated with 1500 cm^3 conc. techn. sulfuric acid. The reaction is exothermic. After the reaction cooled down to room temperature the sulfonated peat was washed until the washwater was no longer acid, then dried at 110°C and sieved. The grain size fraction 0.5—1.0 mm was used in the experimental work. This particle size is known to give a satisfactory ion exchange by allowing a reasonable rate of flow through an exchanger bed[5,6]. Our own experiments confirmed this assumption. The practically insoluble, fine grained black product, though not as physically resistant as the inorganic zeolites (permutit), maintained its structure after prolonged use.

In all our experiments with sulfonated peat a natural inorganic zeolite (Permutit, B.D.H.) was used for comparative purposes. The two ion exchangers were evaluated on the basis of their exchange capacity expressed in kilograms $CaCO_3$ removed by one cubic meter material.

Experimental part. 200 cm^3 of each exchange material varying considerably in weight — sulfonated peat 100 g and permutit of the same grain size 300 g — were placed in two glass tubes having a bed depth of 12 cm. Each column was treated a few times with 8% NaCl solution and washed with distilled water until washwater was free from excessive chlorides. Jerusalem tap water of 140 ppm $CaCO_3$ hardness was then passed downward by gravity. Samples were taken after every 500 ml for determination of hardness by the soap method. The removal of hardness was practically total. This procedure continued without interruption until effluent hardness reached 20 ppm $CaCO_3$, when the ability for ion exchanging was taken as exhausted. The water flow was then stopped. In the average this happened after 25 l water passed through the peat and after 15 l through the permutit exchanger. In terms of exchange capacity this would mean 17.5 kg $CaCO_3$ hardness removal by one cubic meter sulfonated peat and 10.5 kg $CaCO_3$ hardness removal by one cubic meter permutit. The result of hardness removal by sulfonated peat compares very favorably with the exchange capacity of natural inorganic zeolites (permutit, glauconite) which is generally accepted to be in the region of 7 kg $CaCO_3$ per cubic meter, whereas synthetic inorganic zeolites may have a much higher exchange capacity of about 20 kg $CaCO_3$ per cubic meter material[7].

After exhaustion, the exchangers were regenerated in the usual way by 8% NaCl solution, washed and were ready for the next softening cycle.

The cycle was repeated 8 times with no change in working capacity and no loss in material. Therefore it is probable that peat from the Huleh region, properly sulfonated, can be used as a permanent ion exchanger like permutit and sulfonated coal[8].

As to the water flow rate per hour, we compared sulfonated peat with permutit, using — under the same water pressure — an 80 cm bed depth for both exchangers.

The flow rate was the same in both units.

The ion exchange capacity of the sulfonated peat expressed by one kg material is 5 times that of permutit. In practical application, therefore, sulfonated peat will need less frequent regeneration and consequently need less salt and wash water consumption than permutit. Costs of treatment may be further reduced by using seawater for regeneration[9] in places situated near the sea.

Peat from the Huleh region seems a suitable raw material for water softening after sulfonation, drying and sieving to the 0.5—1.0 mm grain size fraction.

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REFERENCES

1. GANZ, R., 1906, German Patent 197111.
2. BRODERICK, S. J. and BOGARD, D., 1941, *U.S. Bureau of Mines, Report of Investigations No.* 3559.
3. LIEBKNECHT, O., 1940, U. S. Patent 2206007.
4. KUNIN, R. and MYERS, R. J., 1952, *Ion Exchange Resins*, 52.
5. KUNIN, R. and MYERS, R. J., 1952, *Ion Exchange Resins*, 141.
6. SZYPOWSKI, W., 1951, Simple method for improving rural water supply, *Gaz, Woda i Techn Sanit.*, **25**, 273.
7. TAYLOR, E. W., *The examination of water supplies*, 654.
8. SHAWELL, E. B., Ion exchange for water treatment, *J. A. W. W. A.*, **43**, 525.
9. THOMPSON, J. and GARVEY, F. Mc., Ion exchange treatment of water supplies, *J. A. W. W. A.*, **45**, 146.

Received November 29, 1953.

A Simple Method for the Evaluation of Moisture in Milled Products

In order to help small flour mills operating in Israel to prepare a flour of a relatively constant moisture content, the possibility of developing a simple method of moisture determination was investigated. The cobaltous chloride method, previously employed for the estimation of moisture in raisins[1] and relative humidity in air[2] was adapted for use in the evaluation of moisture in milled products. For moisture determination in wheat, the sample was milled in a laboratory mill (Micro-pulverizer). The application of the method for moisture estimation in coarse bran was difficult because of the somewhat unsatisfactory contact of the tested sample with the filter paper.

An adsorptive filter paper (Whatman No. 3 round sheets of 11 cm diameter) was soaked for one min. in a conc. cobaltous chloride solution (50%) in a large porcelain basin. The drained paper was dried by spreading single sheets on inverted half Petri dishes and kept at 50° C for 4 hrs. In order to secure a uniform colour, it was necessary to dry the paper in single sheets and use the part dried in air (without contact with the glass). After trimming off the edges to the required size, the filter paper was allowed to cool in a desiccator over calcium chloride and redried (for ½ hr.) before each use.

The lower part of a Petri dish was completely filled with the tested substance, the surface of which was flattened by means of a metal spatula (as employed for the Pekar test in flour). The smooth surface was quickly covered with a round sheet of impregnated filter paper and then with the lid of the Petri dish. In order to secure a better contact of the filter paper with the tested material, it was found advisable to invert the dish for at least the first hour. When a large number (6—10) of tests were carried out simultaneously, it was found advisable to fill *all* the Petri dishes first and then cover them with the filter paper.

After each determination the adhering particles of the tested substances were brushed off and the paper redried, so that the paper could be used for another test.

Two methods were employed for the evaluation of the moisture in various milled products:

1) *Standard colour method*

This method allows absolute measurements. The standard test paper was prepared by placing it on a flour sample of 14% moisture in a Petri dish for 120 min., when a red-lilac colour was attained. The paper was removed from the flour sample and kept in a sealed Petri dish. The time required for the attainment of the standard colour of the unknown samples was found to be in proportion to their moisture content. By employing this method, differences in moisture content as small as 0.5% could be determined in the range of 13—15% moisture.

2) *Standard time method*

This method allows only relative measurements. It was found to give better results in the hands of inexperienced workers since it was simpler and did not necessitate the use of a standard. Another advantage of this procedure was the possibility of its application in samples containing less than 13% moisture. Whereas the first method required more than 3 hrs., the second required only 2—3 hrs.

For each range of moisture content, optimal time of observation was found. The higher the moisture content, the shorter the time. Moisture differences of 0.3% could be determined. Moisture in 150 samples of wheat, flour and bran was determined. The results were compared with those obtained for the same samples by drying at 103°C, (±20) and they were found to correspond closely.

TABLE I

Moisture range and optimal observation time

Moisture range (%)	Time (min.)
12.1—13.0	120
13.0—14.0	90
14.0—15.5	60

The standard time method was found valuable for rapid on-the-spot checking of the daily variations in moisture content of milled products which are usually tested only about every fortnight by the conventional laboratory method. It was found most suitable to prepare a large (1—2 kg) sample and store it in a hermetically closed container. The water content of this sample was determined, and the moisture content of milled products could be compared by the miller in the flour mill on consecutive days by the described method.

The origin of the samples, their particle size (except coarse bran) had only a negligible influence on the results.

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REFERENCES

1. Chace, E. M. and Church, C. G., 1927, *U.S. Dept. Agr. Techn. Bull.* 1.
2. Solomon, M. E., 1945, *Ann. Applied Biol.*, 32, 75.

Received February 24, 1953.

Effect of Versene (Ethylenediamine Tetraacetic Acid) on the Proteolytic Activity of Taka-Diastase

The proteolytic activity of the mould enzyme preparation Taka-Diastase (T.D.) towards several peptides has been described previously[1]. Since it is known that the presence of bivalent metal ions is important for the action of various exopeptidases[2,3,4], it appeared to be of interest to find out whether these ions also play a role in the proteolytic activity of T.D. The study of the effect of Versene (ethylenediamine tetraacetic acid), a powerful complexing agent for polyvalent metal

ions, on the proteases of T.D. was chosen as a first step towards the elucidation of this question. It was found that the proteolytic action of T.D. on alanylglycylglycine, leucylglycine, and leucinamide was completely inhibited by Versene in a concentration of 0.01 per cent of the latter. The cleavage of leucylglycylglycine was inhibited to an extent of about 80 per cent, this figure not being significantly increased by a twofold increase of the Versene concentration or by preincubation of the enzyme with Versene. Possibly, the T.D. preparations contain, among various exopeptidases, one of the type of calf thymus "tripeptidase"[5] which apparently does not require the presence of a metal ion for its action.

T.D. readily hydrolysed, in addition to chloroacetyltyrosine[1], chloroacetylphenylalanine,chloroacetylleucine and chloroacetylvaline. The cleavage of all these substrates was completely inhibited by Versene (0.01 per cent).

The experiments with peptides and chloroacetyl amino acids (concentration 0.3 to 0.8 per cent) were carried out in buffered phosphate solution (pH 7.5 to 8.0). The solutions contained 0.4 per cent T.D. (Parke, Davis & Co). The substrate solutions were previously adjusted to the appropriate pH by addition of sodium hydroxide. With the exception of L-leucinamide and chloroacetyl-L-tyrosine, the racemic form of the substrates was used. The reaction mixtures were incubated under toluene for about 20 hours at 36° with or without Versene. Disodium versenate, analytical grade, was used; its concentration in the reaction mixture was 0.01 per cent. The addition of Versene did not alter the pH of the mixtures by more than 0.1. The extent of the cleavage was measured by Soerensen's formol titration method.

Whereas the importance of bivalent metal ions for most of the known exopeptidases of plant and animal origin is a well established fact, their necessity for proteinases still appears to be dubious. We investigated, therefore, the cleavage of casein by T.D. using Anson's method[6] which measures specifically the action of proteinases. Eight tenth per cent solutions of T.D. in 0.1 molar phosphate buffer (pH 8) were kept overnight at 36° under toluene with or without Versene (The difference in pH of these T.D. solutions did never exceed 0.1). They were then added to equal volumes of a weakly alkaline 1 per cent casein solution, and the mixtures (pH 7.8 to 8.0) were incubated at 36° for 3 hours. After addition of trichloroacetic acid and centrifuging, the extent of cleavage was measured colorimetrically using the phenol reagent of Folin and Ciocalteu[7]. It was found, after substraction of the blanks, that the mixtures containing Versene (0.01 to 0.02 per cent) showed 50 to 65 per cent less cleavage than those without the complexing agent. Only a very small inhibition was observed when Versene was added to the reaction mixtures without preincubation.

These inhibiting effects of Versene indicate the importance of metal ions for the various proteases contained in T.D. The complete inhibition obtained in most cases suggests that the metal ions are necessary for the enzyme action itself (as postulated by E. L. Smith[3,4]) rather than for the stabilisation of the enzyme. However, a mere stabilising effect (similar to that suggested by Bier and Nord[8] and by Gorini[9]) is not excluded, under the conditions of our experiments, in the case of the cleavage of casein. The question, whether the presence of metal ions is necessary for the primary T.D. attack on proteins, requires therefore a further elucidation.

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REFERENCES

1. Lichtenstein, N., 1944, *Nature*, **154**, 362; 1947, *Exper. Med. and Surgery*, 5, 86.
2. Johnson, M. J. and Berger, J., *in* Nord, F.F. and Werkman, C. H., 1942, *Advances in Enzymology*, New York, 2, 69.
3. Smith, E. L., in Nord, F. F., 1951, *Advances in Enzymology*, New York, **12**, 191.
4. Smith, E. L. *in* Sumner, E. J. B. and Myrback, K., 1951. *The Enzymes*, New York, **1**, 793.
5. Ellis, D. and Fruton, J. S., 1951, J. *biol. Chem.*, **191**. 153.
6. Northrop, J. H., Kunitz, M. and Herriott, R. M., 1948 *Crystalline Enzymes*, New York, p. 303.
7. Sumner, J. B. and Somers, G. F., 1949, *Laboratory experiments in biological chemistry*, New York, p. 83.
8. Bier, M., and Nord, F. F., 1951, *Archives Biochem. and Bioph.*, **33**, 320.
9. Gorini, L., 1951, *Biocim. et Biophys. Acta*, 77, 318; 1952. *C. A.*, 46, 1047.

Received November 6, 1953.

The Detection and Estimation of Small Amounts of Untreated Soyabean Flour in Cereals

The detection of the admixture of dark to white wheat flour is made possible by the fact that the former is enriched in this country with 3% untreated soyabean flour. For the identification and estimation of soyabean flour, a microscopic and serological method have been suggested, which are both cumbersome and not applicable to very small quantities[1-6]. Various chemical methods[2,5,7-11] which have been proposed did not seem attractive; following Takeuchi[12], the determination of urease which is a characteristic constituent of soya flour has been applied successfully to the problem.

The usual method consists[2,3] in mixing the sample with a 2% aqueous urea solution and immersing partially a strip of red litmus (or bromophenol) paper into the liquid. The mixture is then kept at 40°C for 3 hrs. and the paper examined for colour changes resulting from the liberation of NH_3. In this form, the method did not permit the detection of soyabean flour in amounts lower than 1%, and even in this case the colour

change was rather difficult to ascertain. Eventually, the method described by Feigl[13] was found satisfactory: if a neutral solution of manganous and silver salts is treated with ammonia, a black adsorption compound is formed:

$$Mn^{++} + 2Ag^{+} + 4OH^{-} \rightarrow MnO_2 + 2Ag \quad 2H_2O$$

The method permits the detection of 0.005 mg NH_3, the concentration limit is 1 in 10^7 [14].

Procedure

1) A small quantity (1 g) of the material to be tested is poured into a micro-test tube, closed by a small ground-in glass funnel.
2) 1—2 ml of a 5% aqueous urea solution is added and mixed thoroughly.
3) The test tube is stoppered by the funnel, into the stem of which is inserted a small 5×3 cm rolled piece of Whatman No. 1 fllter paper moistened with Feigl's solution [1g of solid silver sulfate added tc 11.8 g of manganous sulfate (septahydrate) in 100 ml of water]. The filter paper extends 5 mm into the test tube (without coming in contact with the mixture).
4) The tube is kept at 40°C for 3 hrs. The appearance of a black spot on the filter paper (usually on the extending lower end) indicates that ammonia has been liberated.

The filter paper moistened by the silver solution should not be exposed to direct light; otherwise the detection of minute amounts of soyabean flour is somewhat obscured by the appearance of silver spots.

The method was employed for the detection of untreated, defatted soyabean flour in wheat flour, bread dough and macaroni.

Both samples prepared in the laboratory and taken directly from the processing plants were used. In all the products additions of as little as 0.03% of untreated soyabean flour could be detected. The method was inapplicable to the detection of soyabean flour in bread.

No spot was observed in tests made with various cereal products containing no soyabean flour.

In order to determine the presence of soyabean flour in fresh bread dough the following procedure was employed:

280 g of white wheat flour were made into a dough by the addition of 160 ml of a 2.5% sodium chloride solution to which 5 g of compressed baker's yeast was added (alternatively an equivalent amount—2.0 g—of dried baker's yeast was used). The dough was kept at 35°C for 2 and 4 hours. At the end of the mentioned period a small portion of the dough was made into a milky suspension by kneading it with about twice its amount of a buffer solution in a small glazed porcelain mortar.*

Comparing the time of appearance and the size and especially the colour density of the black spot obtained under equal testing conditions (amount of tested sample, temperature, length of extending filter paper) allowed the estimation of the amounts of soyabean flour present in the different samples.

Results

Several series of flour and macaroni samples containing additions of 0.03, 0.05, 0.10, 0.25, 0.50, 1.00 and 3.00% of defatted soyabean flour respectively were prepared. In each case the amount of soyabean flour could be roughly estimated by observing the time necessary for the appearance of the black spot. The time varied between less than 10 minutes in the sample containing 3% and 3 hrs. in the sample containing 0.03% soyabean flour.

TABLE I

Soyabean Flour %	Appearance of spot (min.)
0.03	120—180
0.05	95—120
0.10	70—95
0.25	45—70
0.50	25—45
1.00	10—25
3.00	<10

In another series of experiments, all samples were kept for 3 hrs. at 40°C. At the end of this period the filter paper was removed from the funnel, flattened, and the size and the intensity of the black spots were compared. Both factors showed a good correlation to the amount of soyabean flour present in the range from 0.03% to 3%.

For comparison served spots obtained, under specified test conditions, on filter paper from samples containing known additions of soyabean flour.

The technical aid of Miss H. Adler is hereby appreciated.

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REFERENCES

1. NICHOLS, J.R., 1945, *Aids to Analysis of Food sand Drugs*, 6th Ed., Bailliere, Tindal and Cox, 274 pp.
2. LA WALL, C. H. and HARRISON, J. W. E., 1934, *J. Assoc. Official Agr. Chem.*, **17**, 329.
3. LA WALL, C. H. and HARRISON, J. W. E., 1935, *J. Assoc. Official Agr. Chem.*, **18**, 644.
4. KERR, R. H., 1936, *J. Assoc. Official Agr. Chem.*, **19**, 409.
5. MIERMEIER, A., 1942, *Z. Untersuch. Lebensm.*, **84**, 392.
6. FERGUSON, C. S., RACICOT, P. A. and RANE, L., 1942, *J. Assoc. Official Agr. Chem.*, **251**, 533.
7. HALE, M. W., 1945, *Food Research*, **10**, 60.
8. MUNSEY, V. E., 1947, *J. Assoc. Official Agr. Chem.*, **30**, 187.
9. HAYWARD, G. W., 1939, *J. Assoc. Official Agr. Chem.*, **22**, 552.
10. HENDREY, W. B., 1939, *Ind. Eng. Chem. Anal. Ed.*, **11**, 611.
11. LYTHOPE, H. C., FERGUSON, C. S. and RACICOT, P. A., 1941, *J. Assoc. Official Agr. Chem.*, **24**, 799.
12. TAKEUCHI, T., 1909, *Journal Coll. Agric.*, Tokio (Japan), **1**, 1.
13. FEIGL, F., 1943, *Manual of Spot Tests*, Academic Press, New York.
14. VOGEL, A. Y., *Quantitative Chemical Analysis*, 3rd ed. Longmans, Green & Co., London, 234 pp.

Received February 24, 1953.

* 5 g of Na_2HPO_4 .12 H_2O and 6 g of KH_2PO_4 per litre.

The Effect of Spraying with Sugar Solution on Establishment of Tomato Transplants and on Subsequent Growth

Following up the investigations of Went and Carter[1] and of Smith and Zink[2], experiments were conducted in the Jordan Valley in the summer of 1952 in which tomato plants were sprayed with a 10 percent water solution of table sugar. The effect of the sprays on the establishment of transplants was tested by means of the following treatments: (a) one spray per day on three successive days preceding the planting out date; (b) unsprayed control; (c) pre-planting sprays in the nursery as in treatment (a), and a single field spray on the day after planting; (d) the post-planting spray as in (c), alone. One batch was planted out on September 3, and another on the following day. The average temperatures were 28.8 and 29.0°C, while the maximum temperatures amounted to 36.0 and 36.1°C for the two planting dates, respectively. During the week after planting a rise of 1°C in the average temperature took place.

The spray applications resulted in better establishment of transplants, as shown by the following data:

Treatment	(a)	(b)	(c)	(d)	s.d.*	h.s.d.*
Percentage of surviving transplants	64.8	37.6	74.1	49.6	11.2	15.4

The pre-planting spray application, as in treatment (a) above, was repeated later in the season. Planting out in the field was carried out on October 2. The sugar spray resulted again in improved survival of the transplants. It was found that, upon removal from the nursery, the treated plants had a lower moisture content than control plants. Subsequent growth in the field was enhanced, as indicated by the number of roots, the height of plants, and the early yields (see following table).

Treatment	Control	Sprayed	s.d.*	h.s.d.**
Percentage of surviving transplants	66.5	86.0	11.1	16.9
Moisture content expressed as percentage of dry weight	743.2	643.9	—	—
Height in cm 38 days after planting	45.7	52.5	4.6	—
Kg per dunam of fruit in first 3 pickings	393.6	499.2	74.4	—

* s.d. — Difference required for significance.
** h.s.d. — Difference required for high significance.

REFERENCES

1. Went, F. W. and Carter, M., 1948, *Amer. J. Bot.*, 35, 95.
2. Smith, P. G. and Zink, F. W., 1951, *Proc. Amer. Soc. hort. Sci.*, 59, 168.

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Received September 11, 1953.

The Effect of Coumarin on the Growth of Tomato Roots in Cultures

Coumarin has long been known as a germination inhibitor[1]. Observations on the germinating seeds strongly suggested root growth inhibition by coumarin. As this was also supported by reports in the literature[2,3,4], it was decided to test the effect of coumarin on the growth of tomato roots.

Tomatoes of the variety Mormond were used. The tomato roots were grown in tissue cultures and the growth determined by the method described by White[5]. The size of the inoculum was 15—20 mm.

Coumarin in varying concentrations was added to the culture media and its effect on growth measured. Concentrations between .0001—1.0 mg/100 ml were found to inhibit growth. Morphological changes in the roots, such as darkening and thickening of the tips of the main roots, were also noted. Similar changes were also observed in the secondary roots, which inaddition showed curling.

Lower coumarin concentrations between .005 and .05 mg/100 ml, did not affect growth, whereas very low concentrations of .0001—.005 mg/100 ml stimulated growth. The results plotted on a logarithmic scale are shown in Figure 1.

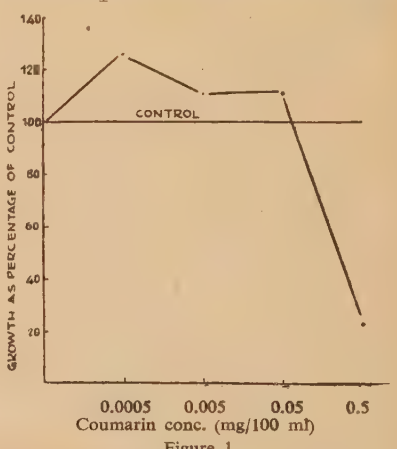

Figure 1

The effect of coumarin on the growth of tomato roots in tissue culture

These results are similar to those obtained by Thimann and Bonner[6] who also found inhibition and stimulation of the growth of coleoptiles by coumarin. Tomato roots are, however, far more sensitive to coumarin, the lowest inhibiting concentration being 1 mg/100 ml for tomato roots and approximately 14 mg/100 ml for coleoptile sections. The results differ from those of Thimann and Bonner, in that in the case of the tomato roots there is no direct transition from stimulation to inhibition, the two being separated by a lag phase.

This suggests the presence of at least two different processes in the growing tomato root which

are affected by coumarin. One phase is sensitive at very low concentrations of coumarin, there being a marked stimulation of growth. The second phase is inhibited by rather higher concentrations. There are apparently intermediary concentrations at which stimulation is just compensated for by inhibition, and growth is almost as in the controls.

No attempts have as yet been made to relate these two coumarin-sensitive phases to any specific physiological processes.

My thanks are due to the late Dr. E. Konis who initiated this work.

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REFERENCES

1. EVENARI, M., 1949, *Bot. Rev.*, **15**, 153.
2. AUDUS, L. J., 1948, *New Phytol.*, **47**, 196.
3. MOEWUS, F., 1949, *Bio. Centralbl.*, **68**, 58.
4. GOODWIN, R. H. and TAVES, C., 1950, *Am. J. Bot.*, **37**, 224.
5. WHITE, P. R., 1943, *A handbook of plant tissue culture*, The Ronald Press Co., New York.
6. THIMANN, K. V. and BONNER, W. D., 1949, *Proc. National Acad. Sci. (U.S.)*, **35**, 272.

Received September 20, 1953.

The Linear Crystallization Velocity of Supercooled Melts of DDT

The enhancing effect of certain compounds on the activity of DDT may be due to their ability to inhibit its crystallization. It therefore became necessary to study the crystallization of DDT quantitatively, and some interesting observations made in this connection are recorded here.

Tamman's[1] method of measuring the linear crystallisation velocity (L.C.V.) was adopted, using capillary tubes of 4 mm diameter; this method has recently been applied to a similar problem connected with trinitrotoluene[2]. McCrone *et al.*[3] have measured the L.C.V. of supercooled melts of technical DDT and of mixtures of DDT with 1,3,5-triphenylbenzene or thymol[4], working with microscopic slides and in a temperature range of 20—35°. In the present investigation, the range between 20° and 105° has been covered.

As a suitable melt can only be obtained if the substance is heated considerably above its melting point, the stability of molten DDT had to be investigated. For the decomposition temperature of DDT, values ranging from 125°[5] to 195°[6] have been recorded. Pure *p,p*-DDT (three times recrystallized from redistilled, iron-free alcohol) shows, indeed, marked decomposition only at 195°, but already at 146° a slight evolution of hydrogen chloride takes place (as indicated by the appearance of turbidity in silver nitrate solution through which a current of air passes from the sample)[6].

At the temperature of 130° which was taken as the upper limit to which the melt could be heated, it became difficult to free the latter from air bubbles even when the heating was continued for several hours; from these bubbles, a sporadic fungus-like growth of crystals set in upon cooling. This difficulty was overcome by cautiously evacuating the capillary tubes at 130° to 1.5 mm pressure, until no more bubbles rose to the surface. The capillary was then kept for a further fifteen minutes in the thermostat at 130°, crystallization induced by seeding or by touching the melt with a metal wire, and the L.C.V. measured over a length of 5 cm. The results have proven to be well reproducible; they are summarised in Table I.

DDT belongs to that group of organic compounds for which according to Tamman's[1] classification the supercooled melt has a maximum value of L.C.V. over a certain *range of temperatures* (67.5—80°).

TABLE I

Temperature (°C)	Time required for crystal growth over a length of 5 cm
23	~500'
35	~180'
40	73'
45	46'
50	25' 37"
55	14' 51"
60	11' 26"
65	8' 10"
67.5	7' 38"
70	7' 36"
72.5	7' 36"
75	7' 40"
77.5	7' 38"
80	7' 39"
82.5	8' 30"
85	8' 38"
90	9' 6"
95	9' 33"
100	10' 24"
105	31' 40"

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REFERENCES

1. TAMMANN, G., 1903, *Kristallisieren und Schmelzen*, Leipzig
2. PELCHOWICZ, Z. and BERGMANN, E. D., 1951, *Bull. Res. Counc. of Israel*, **1** (1-2), 134.
3. MCCRONE, W., SMEDAL, A. and GILPIN, V., 1946, *Ind. Eng. Chem. Anal. Ed.*, **18**, 578.
4. GILPIN, V., MCCRONE, W., SMEDAL A. and GRANT, H., 1948, *J. Amer. Chem. Soc.*, **70**, 208.
5. HUNOLD, G. A., 1949, *Pharmazie*, **4**, 560; 1951, *C. A.*, **45**, 1286.
6. BALABAN I.E. and SUTCLIFFE, F.K., 1945, *Nature*, **155**, 755

Received April 24, 1953.

Cultivation of Wild Forms of Psalliota Bispora (Lge.) Schaeffer and Moeller in Israel

The young mushroom cultivation industry in Israel has shown rapid progress in recent years, and the cultivated, as well as the wild edible fungi that thrive in this country, are gaining ever-increasing popularity as a delectable and nutritious food source. Thus, possibilities were investigated of cultivating some of the most com-

mon edible mushroom species of the genus *Agaricus* occurring here in natural habitats.

For the reasons explained below, special attention was given to the fungus, *Psalliota bispora* (Lge.) Shaeffer and Moeller, collected and identified here for the first time by Professor I. Reichert and Dr. Z. Herschenzon in 1949. Although it was customary to consider the cultivated forms of the genus *Agaricus* (*Psalliota*) as varieties of the common field mushroom *Agaricus* (*Psalliota*) *campestris*, several investigators have found fundamental differences in the anatomy and physiology of these fungi[1,2,3]. They have found instead a close relationship between the common cultivated mushroom and *Psalliota bispora*, which was known to occur in the open in North America and Europe[4]. The common cultivated mushroom and *P. bispora* possess two-spored basidia and marginal cystidia in the gills, while *Agaricus campestris* is four-spored and almost entirely lacks marginal cystidia[2]. For these and other reasons it was postulated by some mycologists that the cultivated mushroom is derived from *P. bispora*[1,2,3]. This hypothesis gained further support when wild *P. bispora*, collected at the University Farm, St. Paul, Minnesota, and from other places, was brought into cultivation in 1949, by employing the ordinary procedure used in commercial production[4], whereas all the attempts by many investigators to obtain fruiting bodies from *A. campestris* under similar conditions have resulted in failure.

The above-mentioned data and conclusions have prompted some cultivation trials with *P. bispora* forms collected by the senior author in Rehovot on the grounds of the Weizmann Institute of Science and the Faculty of Agriculture of the Hebrew University.

Tissue cultures secured from the sporophores grew vigorously on potato-dextrose agar, and some sub-cultures were transferred to Erlenmeyer flasks containing sterile, wet barley grain, where in most cases the mycelium ramified profusely through the medium. This spawn was inserted into horse manure that had first undergone high-temperature fermentation. In three weeks the manure was cased with soil and in three further weeks fructifications were noted (Figure 1).

As mushrooms have never been commercially grown in Rehovot and its vicinity, no possibility exists that the forms of *P. bispora* found wild there were strains that had escaped cultivation in the past. Therefore, the results obtained help to corroborate the existing evidence that the common cultivated mushroom (or at least some of its forms) originated from *P. bispora* growing in nature.

Further studies regarding the yielding ability of these forms of *P. bispora* as well as other species of the genus *Agaricus* are being conducted by the senior author and will be reported in a future publication. Meanwhile it seems worthwhile to emphasize that the possibility of introducing wild edible fungi to cultivation has a promising outlook in Israel.

The authors are greatly indebted to Mr. J. Kovacs, of Pitrael, Mushroom Growing Corporation, of Ramat Gan, for his valuable suggestions and advice, and for putting at their disposal all the necessary facilities for carrying out the actual cultivation trials. They also appreciate very much the help of Dr. Zehara Herschenzon of the Agricultural Research Station, Rehovot, who made available her study of the morphology and taxonomy of the group *Psalliota* in Israel (not yet published).

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REFERENCES

1. Lange, J., 1939, *Flora agaricina Danica*, **4**, 53, Copenhagen.
2. Schaeffer, J. and Moeller, F., 1938, *Ann. Mycologici*, 36, 64.
3. Singer, R., 1949, *Lilloa*, **22**, 431.
4. Wahl, I., 1950, *Phytopathology*, **15**, 793.

Received October 5, 1953,

Figure 1
Psalliota bispora — First "flush" under cultivation.

A Highly Virulent Physiologic Race of Crown Rust on Oats in Israel

An extremely virulent race of *Puccinia coronata avenae* (Corda) Erikss. and Henn., hitherto undescribed, was isolated from collections obtained at uniform oat nurseries located at Masmiya and Mique-Israel.

Our attention was drawn to the fact that some of the oat varieties extensively used in breeding as sources of crown rust resistance became badly infected by crown rust at the above mentioned places. The variety Bond and its derivatives Andrew, Bonda, Clinton, Mindo and Shelby were severely rusted and had pustules of the infection type 4. Santa Fe and its hybrids were practically ruined by crown rust. The same held true for Bondvic and Trispernia. Under these same field

conditions, Landhafer and Ukraine performed considerably better, containing pustules classified as types 3 and 3—. Derivatives of Victoria varied in their reaction. Victoria itself and eight of its derivatives (Boone, Cedar, De Sota, Fultex, Ranger, Tama, Vicland, and Victorgrain) displayed only moderate susceptibility and their crown rust pustules tended to desiccate under dry weather conditions; whereas five other derivatives (Branch, Letoria, Missouri 0-205, Neosho and Osage) were very badly injured. Of all the varieties tested, only Saia was completely immune.

Thirty unipustular isolates secured from Bond, Santa Fe, Trispernia, Ukraine, and Victoria were identified with the aid of the diagnostic key and differential oat varieties provided through the kindness of Dr. H. C. Murphy and Dr. M. D. Simons of the United States Department of Agriculture, stationed at Iowa State College, Ames, Iowa, U.S.A. All of the isolates consisted of a single race, to which the differential varieties reacted in the manner shown in Table I.

TABLE I

Comparative seedling reactions of differential varieties of Avena *spp., grown at approximately 70°F, to a hitherto undescribed physiologic race of crown rust* (Puccinia coronata avenae) *identified in Israel during* 1953

Varieties tested Name	C. I. No.	Dominant seedling reaction
Old set of differential varieties		
Ruakura	2025	Very susceptible
Green Russian	2890	Ditto
Hawkeye	2464	Ditto
Anthony	2143	Ditto
Sunrise	982	Ditto
Victoria	2401	Moderately susceptible
Green Mountain	1892	Very susceptible
White Tartar	551	Ditto
Appler	1815	Ditto
Sterisel	2891	Ditto
Belar	2760	Ditto
Bond	2733	Ditto
Glabrota	2630	Immune
New set of differential varieties		
Anthony	2143	Very susceptible
Victoria	2401	Moderately susceptible
Appler	1815	Very susceptible
Bond	2733	Ditto
Landhafer	3522	Ditto
Santa Fe	4519	Ditto
Ukraine	3259	Very to moderately susceptible
Trispernia	4009	Very susceptible
Bondvic	5401	Ditto
Saia	4639	Immune

The tabulated data prove that the physiologic race under consideration is unusally pathogenic and seems to be more virulent and more aggressive than most other physiological races of *Puccinia coronata avenae*, heretofore reported. On the basis of its performance on the old differential varieties, our race is indistinguishable from race 101 as described by Rosen and Murphy[1]. However, the difference between these two races becomes quite pronounced on the new differentials, since Landhafer, Santa Fe, and Trispernia are resistant to race 101 but susceptible to the race isolated from our collections. The nearest approach to the new race is "raza 45 Argentina", discovered by Vallega[2]. It severely attacks Landhafer, Trispernia, and Ukraine; but Victoria is resistent to it. The susceptibility of Victoria to our races make it readily distinguishable from race 45 of Argentina.

The extraordinary virulence of the new race on seedling and adult plants of varieties that had been used as resistant parental material in oat breeding makes it highly desirable to study the prevalence and distribution of this race in Israel and in the neighbouring countries further, and to assess its responsibility for the heavy losses inflicted to oats in this country. It is obvious that so virulent a rust race constitutes a menace to oat production, the seriousness of which cannot be overemphasized.

The writers are greatly indebted to Dr. M. N. Levine, Pathologist, United States Department of Agriculture, and Guest Professor Elect, The Hebrew University of Jerusalem, for his invaluable suggestions and criticism. Sincere thanks are due also to Dr. Y. Carmon, Director of Research, Ministry of Agriculture, Israel, for his interest and assistance.

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Note added in proof: We have just been informed by the Crown Rust Research Laboratory, Ames, Iowa, U.S.A. that they have designated our crown rust race as race 276.

REFERENCES

1. Rosen, H. R. and Murphy, H. C., 1951, *Plant Disease Reporter*, 35, 370.
2. Vallega, J., 1950, *Revista de Investigaciones Agricolas*, 4, 337.

Received October 12, 1953.

The Persistence of DDT on Various Building Materials

As it is the present practice to spray malaria-threatened areas periodically with DDT, it was deemed of interest to determine the gradual loss of DDT from various building materials generally used in Israel. Defined indoor areas of various building materials were sprayed with a 5% solution of DDT in kerosene (1 g DDT/m^2). During a period of six months (July to January), random samples were taken from different parts of the sprayed surfaces, and their DDT content was analyzed according to Alessandrini[1].

The building materials sprayed were: a white-washed wall, unplaned wood and zinc sheet. After 24 hours, only the zinc sheet retained the total amount of DDT sprayed, whilst from the whitewashed wall and from unplaned wood only 0.80 g and 0.32 g DDT/m^2 respectively, was recovered. Figures 1—3 represent the gradual loss of DDT during six months on the three materials studied; they indicate the decrease in percentages of the initial deposit. Curves of the mean minimum and maximum temperatures and mean relative humidities during the course of the analyses are given in Figure 4.

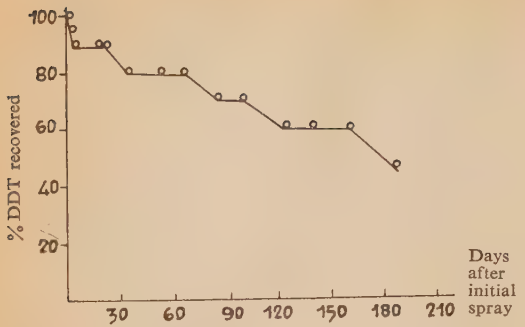

Figure 1. Zinc Sheet.

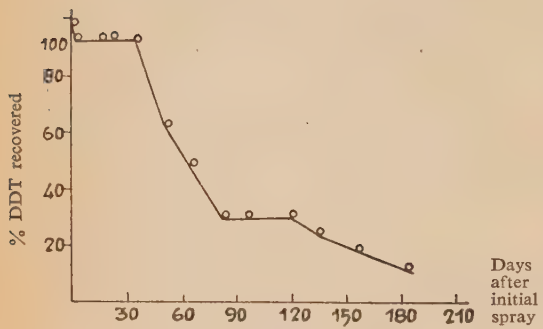

Figure 2 Whitewashed Wall.

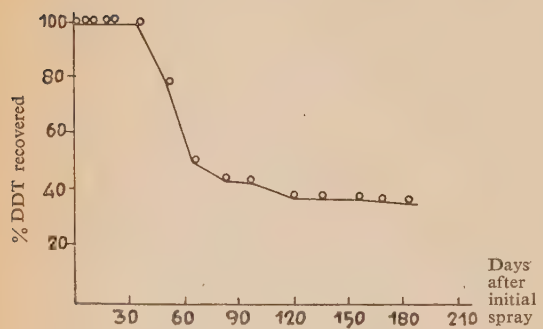

Figure 3. Unplaned Wood.

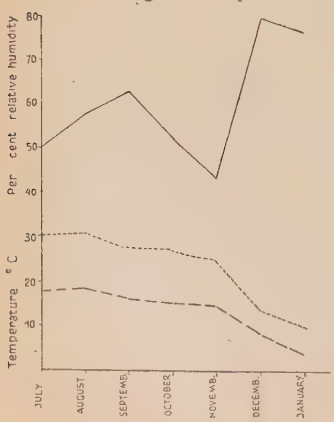

Figure 4.
Mean minimum and maximum monthly temperatures (°C) and mean monthly relative humidities during the course of the analyses.

From oil-painted walls the kerosene solution tends to run off; therefore, inconsistent analytical results were obtained. On Eternite, only 25% of the initial DDT sprayed could be found after one week, and on Masonite no DDT at all could be found after this period.

Our thanks are due to Prof. G. G. Mer, who suggested and directed this work.

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REFERENCE

1. Alessandrini, M. E., 1948, *Ann. Chim. Applicata*, 38, 53

Received August 28, 1953.

Mechanism Involved in Acquired Resistance of *Trichomonas vaginalis* Donné to Colchicine

In a previous communication[1] the progressive selection of strains of *T. vaginalis* resistant to colchicine (up to 1 in 600) was reported. These strains have now been maintained for periods varying from two to two and a half years on colchicine free medium, and when tested at the end of the above periods were found to retain their resistance to colchicine, defined as the capacity to multiply in concentrations fatal to the parent strain, as a stable character.

A study of the range of concentrations compatible with multiplication for each strain in ascending order clearly shows that resistance is not acquired gradually e.g. a strain which has become resistant to a concentration of 1 in 3000 grows in concentrations of 1 in 1,400 without any further "training". Similarly, when a strain attains a resistance of 1 in 1,100 it also grows in a concentration of 1 in 700. The whole process of increasing resistance from 1 in 12,000 (the original maximum concentration compatible with slight multiplication in the parent strain) to 1 in 600 involves not more than five steps.

The ability to survive without multiplying in relatively high concentrations is in itself no indication of resistance to colchicine in the case of *T. vaginalis*. Cultures of the flagellates, on 2% proteose peptone in saline buffered to pH 6.4 with the addition of 10% inactive cow serum, and a trace of liver extract, attain their maximum population after 3 or 4 days growth and after this period the population rapidly dwindles till few or no flagellates remain on the 6th and 7th day. If colchicine is added to the extent of 2.3% of the total medium after three or four days growth of a strain which had no previous contact with the drug, a number of active flagellates are found 48 hours later and these flagellates, after transfer to colchicine free medium, often produce normal cultures. The strain used for the above experiment was naturally relatively resistant to colchicine and grew in a maximum concentration of 1 in 2,000. In this case the non-dividing

flagellates present in cultures after the period of maximum multiplication survived a concentration of the drug 46 times greater than that tolerated by dividing flagellates in young cultures of the some strain.

The establishment of resistance in *T. vaginalis* by subculture on gradually increasing concentrations of the drug is a complex process. Adler and Meerovitch[2] found that all the resistant strains kept on colchicine free medium for a period up to 9 months produced normal cultures when tested on medium containing the drug. Subsequently, while retaining their respective resistance to the full, all these strains produced abnormal forms in the presence of colchicine. These abnormal forms included large a-flagellar amoeboid and spherical masses up to 70 μ in diameter and containing up to 100 nuclei, many of them hypertrophied, and a varying number of blepharoplasts which frequently bore no relationship to the number of nuclei. All gradations between normal and extreme abnormal forms occurred in the same culture. Division in these giant forms when it occurred was unequal, small masses of protoplasm 10 μ circ. in diameter being slowly detached from the main mass. In some cases the protoplasmic bridge connecting the two unequal masses was retracted and the smaller was re-incorporated into the main mass. It appears that many of the abnormal forms are non-viable because material in which they predominate yields either no growth or normal cultures when transferred to colchicine free medium. The normal cultures thus obtained again produce abnormal forms in the presence of small amounts of colchicine but the numbers of abnormal forms diminish continuously with each successive subculture on medium containing the drug. The production of the above large multinucleatic organisms which have not the remotest physical resemblance to *T. vaginalis* is due to physical changes induced by colchicine in the protoplasm of the fully resistant organisms after prolonged growth (for a minimum period of about 600 nuclear divisions) on colchicine free medium. As a result of these physical changes division of the protoplasm is inhibited. Similar but much less pronounced changes are produced by colchicine in metazoal cells. In the case of the flagellate, and in marked contrast to what occurs in metazoal cells, nuclear division is not arrested because the nuclear wall persists throughout the whole process of mitosis and protects the chromosome from the action of the physically changed protoplasm, According to Murray et al.[3] the above action of colchicine on the protoplasm in the case of fibroblasts is antagonised by meso-inositol; in the case of *T. vaginalis* the effect of the colchicine (which occurs in all ranges of pH from 6.4 to 7.0) is pronounced even in medium containing 7.5% meso-inositol.

The above response to colchicine, which has been observed regularly in resistant strains kept for up to more than two years on colchicine free medium and tested at intervals, is evoked by concentrations of the drug much smaller than those to which a strain is resistant. Thus it occurs in all concentrations from 1 in 6,500 to 1 in 900 in a strain which produces rich cultures in the latter concentration. On the other hand, resistant strains grown and maintained constantly ab initio in their respective concentrations of colchicine produce normal cultures.

It thus appears that in obtaining resistant strains of *T. vaginalis* by growth on gradually increasing concentrations of colchicine two distinct factors are involved — one which enables the flagellate to divide and maintain its normal morphology in the presence of the drug, and another which abolishes the lethal action of the drug, but does not inhibit its effect on the protoplasm. The first factor is transient, disappears in the absence of colchicine after about 600 divisions and may therefore be considered as a temporary adaptation (on the above mentioned medium *T. vaginalis* divides on an average once every 10 hours). The second factor is permanent, has persisted unaltered for a period of more than two years of growth on colchicine free medium and may therefore be regarded as a mutation. This interpretation is supported by the following experiment. A resistant strain maintained for more than two years on colchicine free medium produced abnormal a-flagellar multinucleated giants in all concentrations from 1 in 18,000 to 1 in 1400. It was subcultured continuously on concentrations of 1 in 3000 and after 9 passages (36 days) produced cultures consisting almost entirely of normal flagellates, but innumerable abnormal giants still occurred on further subculture in 1 in 1,400 colchicine. It is therefore evident that a re-adaptation against the effect of the drug on the physical properties of the protoplasm was established, but the range of this re-adaptation had no quantitative relationship to the range of resistance. Although the two above indicated factors are independent (in so far as one persists after the other has disappeared) both were apparently involved in the original process of selecting resistant strains. The adaptation which enabled flagellates to maintain normal division and morphology in the presence of colchicine favoured the production of a maximum number of viable flagellates for the selection of resistant mutants.

The adaptation is evoked gradually by the colchicine and eventually disappears in the absence of the drug; on the other hand, the mutation once established persists for at least two and a half years in the absence of the drug.

The above analysis indicates that the mechanism involved in selection strains of *T. vaginalis* resistant to colchicine by culture in gradually increasing concentrations cannot be considered as a single process, whether of mutation or adaptation, since both are involved. In the presence of both factors normal viable flagellates are produced in large numbers in media containing rela-

tively high concentrations of colchicine but after the adaptation has disappeared large numbers of non-viable monsters are produced in presence of the drug.

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REFERENCES

1. ADLER, S., BACK, A. and SADOWSKY, A., 1952, *Nature*, 170, 930.
2. ADLER, S. and MEEROVITCH, E., 1952, *Bull. Res. Counc. of Israel*, 2, 202.
3. MURRAY, M. R., DE LAM, H. H. and CHARGAFF, E., 1951, *Experimental Cell Research*, 9, 165.

Received December 22, 1953.

On the Diagnosis of Bilharziasis in Israel by Immunological Methods: A Preliminary Note on the Value of Extracts of Schistosoma mansoni Worms

Bilharziasis has assumed a new importance in Israel with the mass immigration from countries of the Middle East, in many of which the disease is endemic. The customary diagnostic methods are known to be insufficient, and the present investigation was undertaken with a view to elaborating techniques for skin and serological tests which would detect the maximum number of cases.

The use of the skin (intradermal) test as a means of diagnosis was introduced by Fairley and Williams[1] in 1927 who used an extract of the hepatopancreas of infected snails. Risquez and Boza[2] employed an extract of cercariae for this purpose and Oliver-Gonzalez and Pratt[3] utilised, in addition, adult worms of *S. mansoni*. The active principle is also present in worms of allied species, and amongst others, extracts of *Fasciola hepatica* have been used[4]. Similarly, different extracts of snail hepatopancreas[5], cercariae, adult schistosome[6] and other worms[7] have been shown to fix complement in the presence of sera suffering from one or other form of bilharzia.

Antigens were prepared from

1. Hepatopancreas of snails (*Astralorbis glabratus*) infected with *S. mansoni*.
2. Adult worms of *S. mansoni* recovered from infected laboratory animals.

and 3. Adult worms of *F. hepatica*.

These extracts were tested in a total of 70 patients with chronic bilharziasis, proven by recovery of eggs in the stool, urine or biopsy specimen, and 304 healthy persons or patients suffering from non bilharzial disease. 64 of the proven cases hailed from Yemen, Iraq, Morocco or Egypt, and had brought their infestation with them. Six patients were infected in this country by bathing in the Yarkon river.

For the skin test, extracts were made in 0.85% sodium chloride solution or in buffered 0.4% phenol saline (Coca's solution). Alcoholic extracts of the snail hepatopancreas and of the worms as well as Coca's extracts from the latter, were examined in the complement fixation test (C.F.T.). Different fractions of these substances were also tested serologically and these results will be reported elsewhere.

In the case of the snail liver extracts, 0.2 ml of a solution of 1 : 1,000 was injected in one forearm, a similar extract of uninfected snail being injected in the opposite forearm as a control. The worm antigens were injected in 0.1 ml amounts and Coca's solution employed as a control. Schistosome extracts were used at a dilution of 1:10,000, Fasciola extracts at 1:5,000, these concentrations being chosen as a result of preliminary tests. Skin tests with extracts of *S. mansoni* worms diagnosed 90% of the clinical series and gave only 1.2% "false positive" results in the control series. Snail

Summary of results of skin and complement fixation tests in 70 Cases of chronic bilharziasis and 304 control subjects

Antigen		Skin Test Pos.	Neg.	Doubt	Total	Complement Fixation Test Pos.	Neg.	Doubt	A.C.	Total
Patients with Chronic Bilharziasis										
Schistosome Worm	No.	47	4	1	52	51	5	3	0	59
	%	90	8	2	100	86.5	8.5	5	0	100
Fasciola Worm	No.	20	9	1	30					*
	%	66.6	30	3.3	100					
Snail Hepatopancreas	No.	32	3	1	36	13	7	0	4	24
	%	89	8.3	2.7	100	54.2	29.2	0	16.6	100
Controls										
Schistosome Worms	No.	3	270	2	275	1	296	2	0	299
	%	1.2	98	0.8	100	0.33	99	0.66	0	100
Fasciola Worm	No.	4	30	2	36					*
	%	11.1	83.3	5.6	100					
Snail Hepatopancreas	No.	9	21	3	33	1	4	0	3	8
	%	27	64	9	100	—	—	—	—	—

Fasciola worm extract — titre not adequate for use in complement fixation test.

liver antigen detected 89% of the positive cases but showed 27% "false positives". In addition, results with this antigen were rendered difficult to interpret by the frequent enlargement of the control wheal, and late, painful reactions were common in both groups of persons tested. Extracts of *F. hepatica* were even less suitable, only two thirds of the patients reacting "positive" and the percentage of "false positive" reactors was high at 11%.

In the C.F.T. the titre of the antigens was determined on the day of the test, and the sera examined either by a serial dilution method with constant (1.25 M.H.D.) amount of complement, or by using a constant serum dilution of 1 : 4 with 2, 3 and 5 M.H.D. of complement. The test was deliberately made sensitive as without this delicacy, a number of positive cases would have been missed. Sera from 86.5% of clinical cases reacted positively with an aqueous extract of *S. mansoni* worms, and only 1% of controls exhibited a positive or doubtful reaction. Extracts of *F. hepatica* both in saline and alcohol proved unsuitable for our purpose. Alcoholic extract of snail hepatopancreas on the other hand showed complement fixing activity, but a diagnosis could be made in only 54% of the patients.

Of the antigens so far examined, those obtained from adult worms of *S. mansoni* have so far proved the most specific. When both skin and C.F. tests were used in parallel, the correct diagnosis was obtained in all the positive cases so examined. No control subject, free of the specific disease, reacted positively to both tests. "False positive" results were absent in patients with other parasitic diseases, with allergic diatheses or with positive Wasserman reactions. As far as can be seen, the reaction to the skin test with this antigen is unaffected by treatment of the disease; the cases in which the C.F.T. was followed are too few for a conclusion to be drawn. Thus the result with the combined skin test and C.F.T. using the *S. mansoni* antigen are much superior to those normally obtained by the usual biopsy and egg re-recovery methods, and these techniques should prove especially useful in cases of unisexual infection and in those where few or no eggs are produced.

Our thanks are due to Mr. O. D. Standen of the Welcome Laboratories of Tropical Medicine, London, for his generous gifts of antigen and infected material, and to Professor G. Witenberg of the Hebrew University of Jerusalem for the dried *Fasciola* worms. Full details will be published elsewhere.

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REFERENCES

1. Fairley, N. H. and Williams, F. E., 1927, *Med. J. Austral.*, **2**, 811.
2. Risquez, J. R. and Boza, F. V., 1941, *Gac. méd. de Caracas*, **48**, 289.
3. Oliver-Gonzalez, J. and Pratt, C. K., 1944, *Puerto Rico J. Pub. Health & Trop. Med.*, **20**, 242.
4. Khalil, M. and Hassan, A., 1932, *J. Egyptian M.A.*, **15**, 129.
5. Fairley, N. H., 1919, *J. Roy. Army M. Corps*, **32**, 449.
6. Bozicevich, J. and Hoyem, H. M., 1947, *Nat. Inst. Health Bull.* No. 189, 199.
7. Khalil, M., 1925, *J. Trop. Med.*, **28**, 67.

Received June 18, 1953.

Conocephalus bodenheimer spec. nov. (Tettig. Orth.) from Israel

A Tettigoniid female caught on Mt. Carmel on July 15th, 1951 proved to be a new species of *Conocephalus* (Conocephalinae). It gives the writer much pleasure to name it *C. bodenheimeri* after the zoologist of the Hebrew University of Jerusalem.

Conocephalus Thunberg 1815

Maximum body length is 19 mm. The wings are always longer than the elytrae; they are tailed beyond the abdomen while resting. The cerci of the male always have a tooth. All species have a transparent window-like hyaline, tubercle-shaped posterior margin of the pronotal lobi laterali.

Key to species

1. Length of body, less than 17 mm. Green or yellow all over. Prosternum unarmed. Hind margin of window-like tubercle as well as pronotal lobi laterali nearly straight.....2

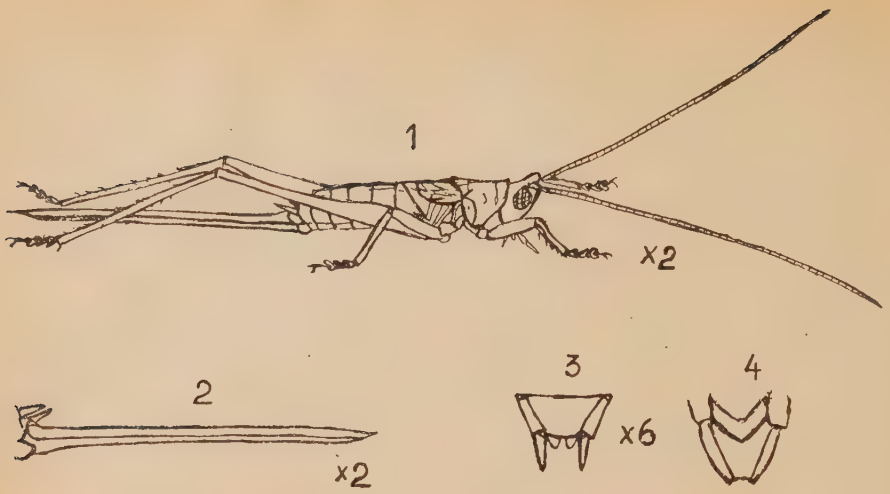
   Yellow-brown line along pronotum and vertex. Prosternum with two teeth. Both hind margin of lobi laterali and window-like tubercle are curved..... 3
2. Male cercus thickened with a long incurved tooth on either inner side near base. Elytrae always long, reaching hind knees, or even longer. Length of ovipositor two thirds of body. Length of body 15 mm.....
   .....*C. conocephalus* L.

   Elytrae shorter, not reaching hind knees. Male cerci with tooth in the middle. Length of body, less than 15 mm.....*C. lugubris* Redt.
3. Wings and elytrae well-developed and long, tooth of male cerci beyond the middle. Length of ovipositor shorter than body, straight and denticulated on its last part.....*C. fuscus* Redt.

   Wings of female (male unknown) almost wanting. Elytrae very short. Length of ovipositor much longer than body, straight and smooth, non-denticulated.....
   .....*C. bodenheimeri sp. n.*

C. bodenheimeri sp. n.

Female resembles *C. fuscus* Fabr. in its features and colourings[1,2]. Brown median line passes over



along whole tergum from vertex to last abdominal tergite. Pronotal lobi laterali with convex, transparent window, its margin behind large and curved (Figure 1). Elytrae reach metanotum, they are very short, almost half the length of the pronotal plate. Prosternum armed with two long teeth. Femurs unarmed with some tubercles on their upper margin. Tibiae of fore- and mid-legs unarmed on their upper margin. Anal plate deeply incised with two rounded lobes on either side, posterior margin of last tergite rounded (Figure 3). Subgenital plate carinated laterally, triangular in shape; lateral margins with triangular emargination at the apex; middle of hind margin almost straight, very slightly concave (Figure 4). Ovipositor brown, one and half of body length, straight and smooth, without granules or denticles, narrow, very pointed at its end (Figure 2).

Lengths in mm: body 15.3, pronotum 4.0, elytra 2.0, femur (of hind leg) 14.5, ovipositor 23.0.

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REFERENCES

1. Buxton, P. and Uvarov B. P., 1923, *R. Bull. Soc. Ent. d'Egypte*, 177.
2. Chopard, 1943, *Les Orthopteres d'Afrique du Nord*, 113

Received April 19, 1953.

Note on the Life History of Blaps tenuicollis Sol. and Blaps cribrosa Sol (Col. Tenebr.)

The yellowish oval eggs (2.5 × 1 mm) are laid from the end of May to the end of October, 1 or 2 cm in the earth, singly, 5 or 6 per day. Oviposition takes place shortly after mating and lasts for several months, totalling 250 to 300 eggs per female. In summer the eggs hatch after 10 to 14 days in Jerusalem at a minimum soil humidity of 10%. The larvae measure about 3 mm long at hatching and grow in 3 months to 4 cm. They are whitish just after eclosion but soon turn yellowish with dark-brown mandibles and legs of which the first pair is stouter, shorter, and stronger than the rest. Nine abdominal segments are visible with the last one modified into a conical shape provided with brown setae. The larvae moult ten times or more. During the moult and shortly afterwards, the larvae remain on or near the surface of the soil until the cuticle acquires a pale yellow colour. The exuviae are left on the surface of the soil. The food of the larvae consists of various kinds of roots and herbs. We fed them in captivity with carrots, sweet potatoes, cucumbers, red beets, animal matter like dead or weakened grasshoppers, crickets, moths, flies. They eagerly took even frozen fish, quaker oats, biscuits, bread and the like. The larvae also eat soil. The larvae, as well as the eggs, require a minimum soil humidity of 10% which is maintained by dew in nature. In the laboratory, if the soil becomes too dry, the larvae come up to the surface and creep around aimlessly and die in a few days. The larval period lasts for about 6 months at the end of which the larvae seek dry and hard soil for pupation. The pupal chamber is formed about 10 cm below the surface of the soil and measures approximately 4 cm in length and 1 cm in width. The yellowish pupa lies on its back and occasionally moves its abdomen. It has a striking similarity to the pupa of *Tenebrio obscurus* having small lateral comb-like structures on all the abdominal segments. The pupal period lasts about 2 months. The adults emerge at any time of the day and almost immediately begin to feed. The *Blaps* are strictly nocturnal insects; their activity starts at sunset, increasing towards midnight and decreases towards early morning. During winter (from end of October to March) they hibernate under large stones or

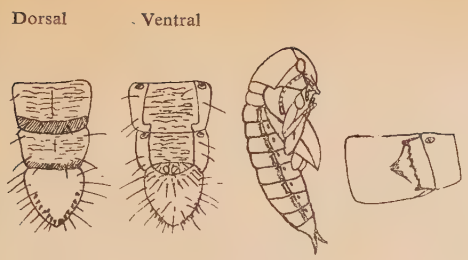

Figure 1
Posterior segments of *Blaps cribrosa* larva — Pupa of *B. cribrosa* showing comb-like structures

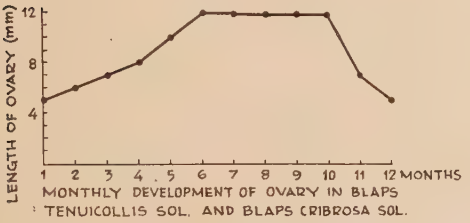

Figure 2

crevices in the earth, often in large groups. Food — mainly decayed leaves — is eaten to some extent during this period. The imaginal food is essentially the same as that of the larvae, but soil is not eaten; yet they are still more omnivorous, adding fresh or decayed fruits, straw, excrements, and perhaps more animal matter. Adults are active from April to October. They copulate and oviposite from end of May onwards. The ovaries are smallest in December an January with an average of 5 mm in both length and width. During February, March, and April the ovaries gradually increase in size and towards the end of May they reach their maximum size of 10 to 12 × 8 mm (containing eggs measuring 2.5 × 1 mm) which they retain till the end of October. At the beginning of November the ovaries shrink to 7 × 6 mm, and in December they reach their minimum size. The size of testes correlates closely with that of ovary. The newly emerged *Blaps* reach their sexual maturity after a few months and live for a few years.

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Received December 13, 1953.

The Rearing, Marking and Trapping of Houseflies (Musca domestica vicina for Dispersal Studies)

The method commonly employed in the study of the dispersal of the housefly is the liberation of large numbers of marked flies and their capture in traps set up at various distances from the point of liberation. To mark the flies, coloured dusts[1] and more recently radioactive phosphorus[3,4,5] have been used. Traps were usually of the wire-cone type similar to those described by Bishopp[2].

This note describes a simple alternative method for the marking, trapping and reexamining of houseflies.

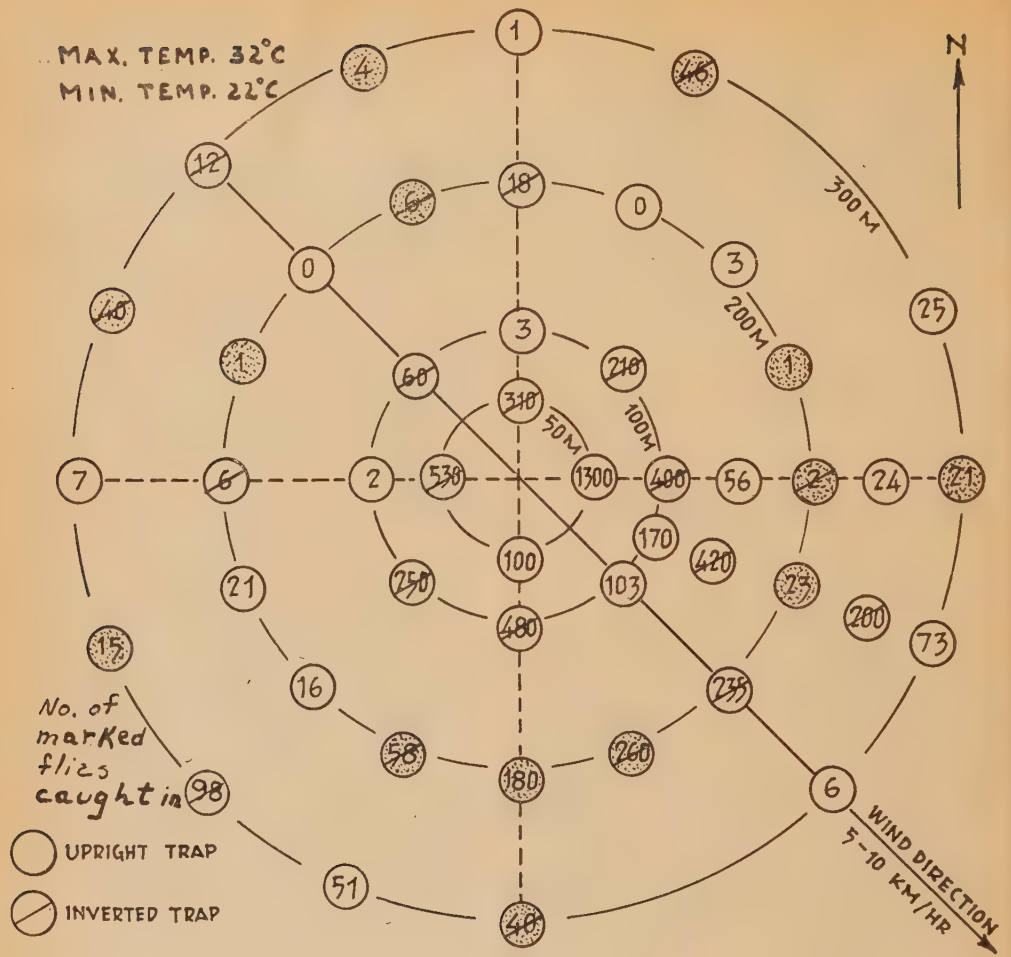
The flies were *reared* in containers (140 × 50 × 20 cm), containing 4½ kg of a mixture of equal parts (by weight) of straw and bran and 18 litres of water. 3 cc of eggs were spread on the surface of the medium. In order to facilitate the collection of the pupae, the containers were inclined so that one end was 5 cm higher than the other. This caused the larvae to migrate before pupation, and concentrate at the upper (drier) end of the container[6]. The upper third of the culture medium containing the pupae was then transferred to a wooden box (47 × 47 × 30 cm) with a hole, 8 cm in diameter, in its lid. On the lid was placed a gauze cage to trap the emerging flies.

To *mark* the flies, they were fed 2 days before the experiment on a mixture of equal parts of sugar and finely divided ferric oxide. The abdomen of the fly became red and remained so several days, permitting an easy identification.

For the *trapping* of the flies, a good bait was necessary. Laboratory experiments showed that 5% baker's yeast in water, which had stood for a week at room temperature in a closed container, and acquired a pungent odour, was most suitable. The traps used were of the usual screen wire cone type except that fly paper was fixed on their inside walls. All flies entering the traps stuck to the fly paper. On the paper background marked flies could easily be identified and counted.

Two types of cone traps were used, an upright and an inverted one. The former consisted of a jar, 15 cm in diameter and 25 cm high, into the mouth of which was inserted a screen wire cone ending with an opening of 1½ cm. in diameter. About 500 cc of bait was placed in the trap and strips of fly paper attached to the inside wall as described above. The inverted type consisted of the same trap, placed on an iron stand, 20 cm high. A beaker containing the bait was placed on the ground underneath the opening of the trap. Black paper was fitted around the lower end of the trap, projecting beyond the upper edge of the beaker, leaving a space of about 7 cm between the edge of the beaker and the black paper. Flies, after feeding, flew upwards towards the light and were caught in the trap.

The following experiment exemplifies the utility of the method described. Forty seven traps (26 of the upright and 21 of the inverted type used alternatively) were set concentrically around the point of liberation at distances of 50, 100, 200 and 300 metres (see map). The experimental site was a flat area with little vegetation and seven kilometres removed from the nearest habitation. 50,000 marked flies were liberated at the centre. The traps were collected 2 days later. 6898 houseflies, i.e. 14% of the flies liberated, were recovered. These flies amounted



to about 5% of the total number of flies captured. At a distance of 50 metres, an average of 572 marked flies was recovered per trap, at 100 metres 190, at 200 metres 48 and at 300 metres 29 flies per trap. With increasing distance, therefore, the number caught decreases rapidly.

On comparing traps of the two types located at equal distances from the centre and at equal angles from the wind direction (marked on the map by dots in the traps), the upright trap caught an average of 35 flies, and the inverted 64.6 flies per trap. The latter type, therefore, seems to be more efficient.

As the map shows, flies disseminated in every direction from the point of release in spite of a prevailing northwest wind of 5—10 km per hour. By dividing the area into quadrants with the direction of the wind as axis, it is seen that in the quadrants with the wind direction, an average of 220 marked flies were caught per trap, whereas in the quadrant opposite the wind direction an average of 68.7 were caught. Thus flies tended to go with the wind rather than against it.

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REFERENCES

1. BISHOPP, F. C. and LAAKE, E. W., 1921, *Jour. Agr. Res.*, **21**, 729.
2. BISHOPP, F. C., 1930, *U.S. Farmers Bull.*, 734.
3. JENSEN, J. A. and FAY, R. W., 1951, *Am. Jour. Trop. Med.*, **31**, 523.
4. LINDQUIST, A. W., YATES, W.W. and HOFFMANN, R.A., 1951, *Jour. Econ. Ent.*, **44**, 397.
5. SCHOOF, H. F., SIVERLY, R. E. and JENSEN, J. A., 1952, *Jour. Econ. Ent.*, **45**, 675.
6. WOLFINSOHN, M., 1951, *Bull. Res. Counc. of Israel*, **1**, 166.

Received December 7, 1953.

Intra-Generic Difference in Chromosome Numbers of Spiny Mice (Rodentia: Murinae)

Spiny Mice of the genus *Acomys* form a well defined group of chiefly African distribution. Some forty forms were named, many of which seem to be of doubtful validity[1]. Two species are known to occur in the Southern Palaearctic region, namely *Acomys cahirinus* and *Acomys russatus*, which are readily distinguishable. Both are found in Israel; the first occurs everywhere in the mountainous habitats of the country, whereas the second is restricted to more or less arid localities.

No representatives of this group were so far examined cytologically. An analysis of the chromosome complements of the local species gave the following results:

Species	2*n*	*Sex chromosomes*	*No. of ♂♂ examined*
Acomys cahirinus Desmarest	38	XY	5
Acomys russatus Wagner	66	XY	2

Although the chromosome complements of these species are entirely different with regard to the number of the elements, the relationship which might exist between the karyotypes suggests itself on the morphological examination of the diploid set. *Acomys cahirinus* possesses comparatively long autosomes, all of them metacentric or sub-metacentric except for four tiny elements which are markedly smaller than the remainder and in which the centromere has not yet been demonstrated. *Acomys russatus*, on the other hand, shows only a graded series of short autosomes in which the position of the centromere has not been established with certainty. The X and Y chromosomes and the form of the sex bivalent are similar in both species. The X chromosome can be identified in spermatogonial metaphase plates, being the largest element in *Acomys russatus* and one of the largest in *A. cahirinus*. The Y chromosome is one of the smallest elements in both cases. Thus the total amount of chromatin is very similar in the two species in spite of the difference in the chromosome numbers.

The chromosome counts reported here are based on the observation of spermatogonial metaphase plates as well as of first and second meiotic divisions. All were made on squash preparations after pre-treatment of the testicular tubules with a diluted Tyrode solution. This technique was developed following a suggestion by Hughes[2]. The results are comparable with the micro-photographs published recently by Hsu[3] and are far better than those obtained by other squash methods and water pre-treatments which were tried by us on a variety of Rodents. This technical improvement makes the observation of Mammalian chromosomes almost as easy and accurate as that of groups which have the reputation of being more favourable for cytological examination.

The detailed results of this investigation will be published elsewhere.

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REFERENCES
1. ELLERMAN, J. R., 1941, *The families and genera of living Rodents*, 2, The British Museum, London.
2. HUGHES, A., 1952, *Quart. J. micr. Sci.*, 93, 207.
3. HSU, T. C., 1952, *J. Hered.*, 43, 167; HSU, T.C., POMERAT, C. M., 1953, *J. Hered.*, 44, 23.

Received, December 15, 1953

The Determination of Corticosteroids in Human Cerebrospinal Fluid

The determination of corticosteroids in cerebrospinal fluid is of both theoretical and practical importance.

The presence of corticosteroids in human peripheral blood[1] and ascitic fluid[2] has been demonstrated. Recently 17-hydroxycorticosterone (hydrocortisone, cortisol) and 11-dehydro-17-hydroxy-corticosterone (cortisone) have been identified[3,4].

In view of the existence of the blood-cerebrospinal fluid barrier and the small quantities identified in blood, it was of interest to investigate whether human CSF contained any appreciable amounts of adrenocortical hormones. If the presence of appreciable amounts of corticosteroids can be demonstrated in human CSF samples and in samples taken from subjects under ACTH and cortisone treatment, the permeability of the blood-CSF barrier could be postulated. The quantities found in samples from patients given in Table I appear to support this hypothesis.

Because of the inhibiting effect of these hormones on connective tissue reactions and formation of fibrosis, their effect on tuberculous meningitis has been investigated and the resolution of subarachnoid adhesions was achieved[5]. Similar results were reported in experimental animals with subarachnoid adhesions due to talc, after treatment with cortisone[6]. It can be assumed that in order to produce a favourable therapeutic effect in patients with adhesions in the subarachnoid space, a certain concentration of corticoids in CSF is necessary.

In view of these considerations, samples of CSF from ten neurological patients were examinhe for corticosteroids. The samples were extracted three times with twice their volume of chloroform (to avoid emulsions). As washing with 0.1N NaOH reduced the values of reducing steroids found, all chloroform extracts subsequent to the fourth sample were washed with 0.1N sodium hydroxide (twice) dried over sodium sulphate and evaporated to dryness at reduced pressure below 45° C. The residue was dissolved in 1.0 m

glacial acetic acid and 0.35 ml and 0.4 ml aliquots taken for the determination of reducing steroids and formaldehydogenic steroids, respectively. In the last two cases and in the pool of CSF from three subjects receiving spinal anaesthesia (kindly supplied by Dr. Aladjemoff), the samples were divided into halves before chloroform extraction and each half worked up as described above. The residue of the second half however was dissolved in 96% ethanol and aliquots taken for formaldehyde determination and for the corticosteroid determination, as described by Gornall and MacDonald[7]. The mean of the two formaldehyde determinations is given. The alcoholic solution was always a little lower, but never greater than 10%.

From the results it appears that the determination of reducing steroids is rather unspecific, whereas the values for formaldehydogenic steroids are considerably less, and those found by the method of Gornall and MacDonald are about half the values of these steroids in blood as determined by those authors. This last method which is very sensitive seems to be the method of choice.

It is intended to analyse extracts of samples of CSF by paper partition chromatography, in order to identify the corticosteroids present.

TABLE I

Patient (Sex)	CSF sample (ml)	0.1 NaOH washing	Concentration per 100 ml CSF: Reducing sreroids γ	Formaldehydogenic steroids γ	Gornall and MacDonald method* γ
R. F. (f)	30	—	1550	1000	
S. M. (f)	5	—	Not detectable		
A. T. (f)	5	—	50		
M. M. (m)	7	+	1080		
	7	—	1430		
L. S. (f)	7	+	130**		
	12	+	80		
D. J. (m)	6	+	1020**		
F. P. (m)	24	+	72		
E. D. (m)	35	+	180	85	
I. S. (f)	60	+	135	70	42
M. F. (m)	52	+	384	110	54
Pool-3 normal subjects	10	+	60	48	36

* Quantitative determination of steroid hormones with 2-4-Dinitrophenylhydrazine (based on cortisone calibration curves.

** During ACTH treatment.

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Since this publication was submitted, it has come to our notice that Dr. D. N. Baron and Dr. D. Abelson have found by paper partition chromatography about 1γ of cortisone and about 2 γ of hydrocortisone in a pooled sample of 500 ml of CSF. (Determination of adrenocortical steroids and their metabolites. *Memoirs of the Society for Endocrinology* No. 21 p. 38, London, November 1953).

REFERENCES

1. NELSON, D. H. and SAMUELS, L. T., 1952, *J. Clin. Endocrinol.*, **12**, 519.
2. COPE, C. L. and MURLOCK, B., 1953, *Brit. Med. J.*, **2**, 841.
3. BUSH, I. E., 1953, *Ciba Symposia on Endocrinology*, **5**,.
4. MORRIS, C. J. O. R. and WILLIAMS, P., 1953, *Biochem. J.*, **54**, 470: 1953, *Ciba Symposia on Endocrinology* **7**,.
5. SHANE, S. J. and RILEY, C., 1953, *New England J. Med.*, **249**, 829.
6. OPPENHEIMER, J. H. and REISLER, W. H., 1953, *Proc. Soc. Exp. Biol. and Med.*, **83**, 844.
7. GORNALL, A. G. and MAC DONALD, M. P., 1953, *J. biol. Chem.*, **201**, 279.

Received December 24, 1953.

The Tremor of September 10th, 1953.

A destructive earthquake took place in Cyprus on September 10th, 1953 at 04^h, 06^m, 00^s, 32°E, 35° N, μ 6½)Pasadena (according to data from the U.S. Coastal and Geodetic Survey. Responses to a macroseismical questionnaire sent to about 300 localities in Israel showed that a tremor occurred here on September 10th, 1953 at 7^h, 7^m-10^m.

Observers described the tremor to have lasted for about six seconds. No sounds were noted. The highest intensity reported was just below the fifth grade. The macroseismical area as reported in Israel may be summarized as follows: In the South—from the Jerusalem Hills to the mouth of Wadi Rubin. In the East—the Jordan Valley. In the North—from Rosh Hanikra to Lake Huleh.

Reporters from Mt. Canaan, Afuleh, Beit Zera, Hahotrim and Haifa described the movement as an upwards one. Its direction was in most cases from West to East or from NNW to SSE. Haifa, Ramat Gan and Kfar Ruppin reported its direction as from N to S.

The areas of highest intensity were belts lying in a NW-SE direction (In the Galilee— Acre-Nazereth, Haifa-Mishmar Haemek, South of Lake Tiberias, Emek Beth She'an. In the Jaffa-Lydda-Gezer area). Similarly to the tremor of 31.1.51[1], only the belt between Lakes Huleh and Tiberias lay in a NE-SW direction. The faults running NW-SE (Erythrean lines[2]) seem to be affected by tremors more than those running in other directions. The Jordan Valley seems to be struck by quakes only where the Erythrean lines pass through it.

In the Central area of the aseismic Sharon, between Caesarea and Nathanya, there was a small sensitive area—Hadera (3-4) and Maabarot (2-3) in the location of the fault which lies between the Carmel "nose" and the Hadera area.

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REFERENCES

1. SHALEM, N., 1952, *Bull. Res. Counc. of Israel*, **2**, 5.
2. SHALEM, N., 1952, The Red Sea and the Erythrean Lines, *Congrés Geologique International*, 19th Session, Sept. 1952.
3. SHALEM, N., 1953, *Bull. Res. Counc. of Israel*, **2**, 438.

Received December 5, 1953.

Propagation of Foot and Mouth Disease Virus in the Syrian Hamster

Skinner[1,2] succeeded in propagating strains of Foot-and-Mouth Disease virus in the unweaned white mouse. His findings placed at the hands of workers in the field of F and M research, a highly susceptible laboratory animal, particularly useful for primary isolation of virus, titration and serum neutralization studies. Furthermore, preliminary observations indicated that the mouse propagated virus can be used in the preparation of the Schmidt-Waldman type of F and M vaccine. Since affected tissues are used in the preparation of the above vaccine, a larger sized laboratory animal, as highly susceptible as the unweaned mouse, would present obvious advantages. Thus, the unweaned white rat which according to Skinner[2] was found to be highly susceptible to F and M virus at the age of 36 hours, will yield infected tissues 3 times that from a 7-10 day old mouse. The white rat, however, has the disadvantage of showing early resistance to infection.

In our laboratory, two strains of F and M virus, Vallée O and A types, were propagated in hamsters. The Syrian hamster, first introduced as a laboratory animal by Prof. S. Adler at the Hebrew University of Jerusalem was now found to be as highly susceptible to infection with F and M virus as the unweaned white mouse. F and M disease virus produced in the hamster an acute fatal infection, clinically similar to that noted in the unweaned white mouse. The hamster does not show an early resistance to infection. At the age of 7 days, affected hamster yields infected tissue about 4 times, and at the age of 22 days when still fully susceptible, about 12 times that obtained from a susceptible white mouse.

Starting with cattle tongue infected epithelium, Vallée O type F and M virus was passaged to the 8th hamster passage. Hamster's heart muscle emulsion in broth, was used for passaging and the standard dose was 0.03 cc of 10^{-1} dilution given intraperitoneally (Table I). Material from the 8th hamster passage was inoculated intradermally in guinea pigs, and typical F and M lesions were noted. The recovered guinea-pigs were tested for immunity with cattle virus, Vallée O type, and were found to be immune.

First passage in hamster of Vallée O type and Vallée A type F and M virus was used to determine the effect of age on the susceptibility of hamsters to infection. Hamsters ranging in age from 9-28 days were inoculated intraperitoneally with the standard dose (Table II). At the above age range, the hamsters were found fully susceptible to infection.

The same virus and dose as above was used to determine the effect of route of inoculation on the susceptibility of hamsters at different ages, to infection (Table III). The results obtained showed hamsters to be susceptible to the three routes of inoculation tested.

TABLE I

Propagation of F and M Vallée type O virus in hamsters

Passage No.	Age (days)	Period of Survival Less than (hrs.)	
		24	36
1	3	3/0	
2	4	2/0	
3	5	2/0	
4	7	2/0	
5	9	2/0	
6	10	2/0	
7	11	2/0	
8	12	2/0	
8	22		2/0

3/0 3 died, 0 survived.

TABLE II

Effect of age on the susceptibility of hamster to infection with F and M virus

Strain of Virus	Age (days)	Period of Survival Less than (hrs.)		
		24	36	48
A	9	4/0		
	22	2/2	2/0	
	28		2/2	2/0
O	9		4/0	
	22		4/0	
	28		2/2	2/0

TABLE III

Effect of route of inoculation on susceptibilty of hamsters to infection with F and M Vallée type O virus

Strain	Route of inoculation	Age (days)	Period of Survival (hrs.)			
			24	36	48	60
A	Intraperi-	9	4/0			
	toneally	22	2/2	2/0		
		28		2/0	2/0	
	Intramus-	9	4/0			
	cularly	22	4/0			
		28	2/2	2/0		
	Intracereb-	9	4/0			
	rally	22	1/3	3/0		
		28	2/2	2/0		
O	Intraperi-	9		4/0		
	toneally	22		4/0		
		28				4/0
	Intramus-	9		4/0		
	cularly	22			4/0	
		28		2/2	1/1	0/1
	Intracereb-	9		4/0		
	rally	22		4/0		
		28				3/1

4/0 4 died, 0 survived.

Following inoculation, F and M virus was found in the heart, brain, liver, spleen and skeletal muscles of the affected hamsters. The titre (Mouse MLD_{50}) of Vallée A type of F and M virus, in the whole body of 10-day old affected hamsters—after removal of stomach, intestine and skull —was determined in 8-day old white mice inoculated intraperitoneally. The preliminary results obtained, indicated that the tissue of infected hamsters are of a very high titre, and justify further work on the effect of other strains of F and M virus on the hamster, the antigenicity of such strains, and the possibility of utilizing hamster infected tissue in the production of F and M Vaccine.

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REFERENCES

1. Skinner, H. H., 1951, *Proc. Roy. Soc. Med.*, **44**, 1044.
2. Skinner, H. H., 1952, *Nature*, **169**, 794.

Received December 20, 1953.

NEWS AND VIEWS

THE ISRAEL MATHEMATICAL UNION

The Israel Mathematical Union was established in Jerusalem on March 2, 1953 by a convention of over sixty mathematicians. After the organizational meeting lectures were delivered by Prof. C. L. Pekeris of the Weizmann Institute of Science, Rehovot, and Prof. A. H. Fraenkel of The Hebrew University of Jerusalem.

The Union will strive to encourage the study of mathematics and to support mathematical research in Israel, and will arrange for scientific and pedagogic conventions. The first convention of this type was held on September 28, 1953, in which about a dozen of short scientific papers were read. The convention devoted part of its time to problems of teaching mathematics in secondary schools.

A committee of the following members is directing the activities of the Union currently: Prof. J. Levitzki, Chairman; Dr. J. Gillis, Vice Chairman; Dr. S. Agmon, Secretary; Prof. N. Popper, Treasurer; Prof. B. Amira; Prof. A. Dvoretzky; Prof. M. Fekete; Prof. A. A. Fraenkel; Prof. E. Netanyahu.

Recently Israel has become a member of the International Mathematical Union with the Israel Union as the adhering organization. As the constitution of the International Union requires that a National Committee for Mathematics be set up in each member country, it was decided that the Committee of the newly formed Israel Mathematical Union will also serve as the National Committee for Mathematics in Israel.

The next meeting of the Israel Mathematical Union will be the annual meeting of 1954, to be held in Jerusalem on January 19.

Anyone in Israel or abroad who wishes to forward the aims of the Union may become a regular member. The Union will also welcome as a supporting member any person or institution which wishes to offer appropriate support to its projects.

Riveon Lemathematika

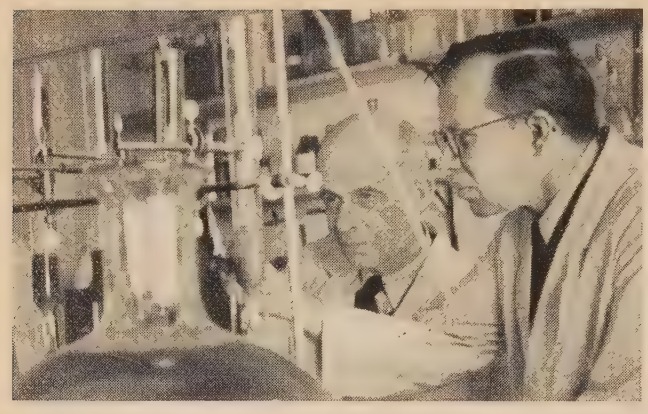
Riveon Lemathematika, a quarterly journal for mathematical study and research edited by Mr. Dov Yarden, has published its sixth volume. Mr. Yarden founded the quarterly in 1946, and has since been maintaining it through his devoted work. In recognition of the contribution of the journal in promoting research in Israel, especially among the young mathematicians, and in support of the sixth volume, The Hebrew University of Jerusalem has decided to present Mr. Yarden with the Raphael Cohen Prize of 1952.

IN MEMORIAM:

PROF. A. REIFENBERG

Israel academic circles, agricultural scientists, all those interested in the exploration of Israel, and creative Zionists deeply deplore the loss of one of their prominent and outstanding colleagues, Prof. A. Reifenberg, who passed away on August 27th, this year. Prof. Reifenberg was Head of the Soil Science Department of The Hebrew University of Jerusalem and member of the University Executive Committee and of its Board of Directors. He had been chairman of the University's Agricultural College in Rehovot, and later, during the difficult years when the University had to rebuild its campus and all laboratories in the new town of Jerusalem, he was Dean of the University's Science Faculty. He was the founder and first editor of the *Israel Exploration Journal*, a well known science and archaeological quarterly designed to bring the results of local regional researches to the knowledge of the scientific world abroad. Owing to his initiative and under his leadership, the Israel Soil Science Society, which links the many scientists working in this field, was founded four years ago. Prof. Reifenberg also held a prominent position in the Israel Army.

Besides his local activities, Prof. Reifenberg was well-known in his field in the international forum. He contributed to all International Congresses of Soil Science and his researches and theories are recorded in almost every textbook of Soil Science. In the International Soil Science Society he held the office of Representative for the Middle East, and was to address, in this capacity, the forthcoming 5th International Soil Science Congress. He was the author of well over a hundred articles and a number of books, among them the *Soils of Palestine* (*Soils of Israel* in the later editions), which is regarded as the standard book on the subject. Among his contributions to fundamental Soil Science were: a world classification system of soils based on the silica-sesquioxide ratio of their clay fraction, kataphoretic measurements on clay suspensions, recognition of the peptizing role of colloidal silica



Prof. A. Reifenberg (left) at work in his laboratory.

in nature, adaptation of Lang's climatic soil-formation index to regions with rainless seasons (the Mediterranean). These last two findings enabled him to propound his well known theory regarding the mode of formation of the *Terra Rossa*, the prominent soil type of the Mediterranean regions. We also owe to Prof. Reifenberg the first schematic soil map of Israel as well as soil maps of Syria, Lebanon and adjoining countries.

Prof. Reifenberg's untimely death was a consequence of his army service during World War II, for which he volunteered out of deep conviction. A ship carrying him and soldiers under his command was torpedoed. Although he was among those who were later rescued from the sea, his heart suffered irreparable damage. His altruistic nature prevented him from avoiding over-exertion during the subsequent years, as prescribed by his medical advisers. He died of a sudden heart attack after he had been ailing for the past year. He was 54 at the time of his death. He leaves a wife and two sons.

The absence of Prof. Reifenberg will be felt in Israel for many years to come.

SYMPOSIUM OF THE ISRAEL SOIL SCIENCE SOCIETY ON CURRENT SOIL RESEARCH IN ISRAEL

The Israel Soil Science Society held its third convention on April 2nd, 1953, at the Agricultural Research Station, Rehovot.

The meeting was presided over by the Society's outgoing chairman, Prof. S. Ravikovitch. The new committee elected at the end of the meeting consists of: Dr. M. Rim (chairman), Eng. A. Muravsky (secretary), Eng. H. Finkel (treasurer), A. Yevnin and Y. Noy, representing the Soil Science Department of The Hebrew University of Jerusalem, the Soils Department of the Agricultural Research Station, Rehovot, the Agricultural Engineering Department of the Technion, Israel Institute of Technology, Haifa, the Government Soil and Water Engineering Departments and the Kadoori Agricultural College, respectively.

The series of lectures was opened by the reading of a letter from Prof. A. Reifenberg, who could not attend this meeting becanse of his ailment. It is due to his initiative that four years ago the society was founded.

The following are summaries of the papers read at the Symposium.

LECTURES

On the Hydraulic Conductivity of Unsaturated Soils

Unsaturated steady flow of liquid-gas mixtures through sands and similar inert porous media at low Reynolds numbers obeys Darcy law. The ratio of the hydraulic conductivity (or permeability) k in unsaturated flow to that of k' in saturated flow, is a universal function of the degree of liquid saturation s (= ratio of the partial volume of water to the porosity). This was confirmed experimentally by Wyckoff and Botset. A theory based on the analogy with the Poiseuille and Kozeny formulae, and using the concepts of mean hydraulic radius and specific grain radius, gives

$$k_L = k'_L \, (s-s_o)^3/(1-s_o)^3$$

s_o corresponding to immobile water in the angles. A similar formula is found for the gas phase:

$$k_G = k'_G \, (1-s)^3/(1-s_1)^3$$

s_1 corresponding to the remaining water hard to expel. Both formulae are in excellent agreement with experiment. An explanation of equilibrium permeability was also given.

It appears that k in unsaturated sands is directly proportional to k' in saturated sand, and to a cubic parabola in s. Soil moisture should therefore be expressed in the non-dimensional s units. All this confirms Gardner's hypothesis that k is a function of soil moisture and indirectly Richard's hypothesis that it is a function of the capillary potential.

S. Irmay
Hydraulics Laboratory,
Technion, Israel Institute of Technology,
Haifa.

The Relation Between the Rate of Evapo-Transpiration and the Settling Rates of Small Air-Suspended Test-Particles onto the Ground

No method has yet been perfected for measuring the diurnal or hourly march of evapo-transpiration or its opposite, dew-condensation. Such information — if it could become available — would enable investigators to distinguish between the different processes that are important in the water regime of land (seepage, solar desiccation, wind desiccation, dew absorption and vegetative moisture dissipation due to transpiration and guttation). A possible mode of obtaining continuous records of the evapo-transpiration rate from a level field or an open water surface by observation of falling test-particles is discussed in the following.

By releasing periodically from a given height, h, tiny test-particles (e.g. fine, uniform sand grains) and recording by an automatic mechanism their arrival times at or near the ground, the state of motion of this ground-close air layer is explored. Since this air-layer's state of motion governs the rate of moisture-dissipation from the ground, too (i.e. evapo-transpiration), a single-valued mathematical relation between the latter and particle settling records could be formulated. The only condition necessary is, that h be chosen very small in relation to the field's extent, in which case the various lateral vector components concerning diffusion and drift of moisture vapour in the centre of this layer cancel mutually.

The scalar value of the remaining upward-directed vapour flux vector may be separated into three additive portions, each of which can be evaluated by proper interpretation of the particle records: (a) *Drift* — effected by persistent convection currents in the considered layer — is calculated from the difference between the predetermined still-air settling velocity of the test particles, w, and their recorded mean settling velocity, w, multiplied by the observed moisture concentration in the air, m. (b) *Eddy-diffusion* — effected by irregularly fluctuating convection currents and random mixing of air pockets — can be evaluated by means of Einstein's formula from the mean deviation, Δz, from the pre-calculated height position, z, of test particles as observed at a time t, after their release. (c) *True molecular diffusion* of moisture vapour — usually negligibly small in relation to eddy-diffusion — is readily obtained using Fick's equation and tabulated values for the diffusion coefficient D.

By combining these three superimposed fluxes, an expression for E, the total rate of evapo-transpiration, is obtained (the differentials contained therein can be integrated for case of use, in different ways fitting different meteorological conditions):

$$E=(1/h)\int_{z=0}^{z=h}(w-\bar{w}).z.dm+\frac{(d(\overline{\Delta z})^2+D)}{2s.\,dt}\cdot\frac{m_{z=h}-m_{z=o}}{h}$$

The number s is a characteristic of the employed test particles, namely, their susceptibility to eolian motion, indicating what fraction of the turbulent motions of the air is conveyed onto them. s is either assumed to be unity or otherwise determined by pre-trial.

M. Rim
Soil Science Department,
The Hebrew University of Jerusalem

The Conversion of Mobile Sands into Agricultura Soils

The possibility of converting, with the aid of soil-building agents, mobile sand surfaces into agricultural land was investigated.

Organic colloidal matter derived from the remains of dead plants grown on the sand surfaces, stable manure and mineral colloids added to the sand in the form of red clay-earth were the soil-building agents tested in the experiments. It was borne out by the results that the organic matter derived from plant remains was the most efficient among the mentioned agents, both as regards physical as well as chemical effects. The sands' light yellow colour changed gradually to a reddish brown, as a result of the quartz grains becoming coated with colloid matter similar to the typical coatings on the grains of the reddish-brown sandy soils in the Sharon and the Shefela bordering the mobile sand region. Aggregates were formed in the previously structureless, free-flowing sand. The percentage of capillary pore space increased, their moisture characteristics improved, their nutritive capacity increased, and the population of micro-organisms — negligibly small in the mobile sand — multiplied.

Addition of inorganic colloidal matter in the form of red clay-earth had comparatively little effect.

Among the crops raised on the experimental grounds, alfalfa, clover and sown pasture crops proved to be the best soil-forming agents. Obtained yields were considerable.

The mentioned changes of the sands' composition and properties greatly enhanced their suitability as a seedbed for various irrigated crops.

The results of the investigation proved that mobile sand could be reclaimed and brought under intensive cultivation without special investments and on a big scale.

S. Ravikovitch
B. Ramati
Agricultural Research Station, Rehovot.

Intake Rate of Water by Soils

The factors which influence the velocity and intake rate according to C. H. Diebold were enumerated, and the importance of the knowledge of intake rate and penetration coefficient for the right planning of irrigation and drainage schemes was emphasized. Details were given on the design and use of instrumentation introduced by the author in Israel and a practical example, based on soil samples of Amir in the Huleh Valley, was cited. A mathematical analysis of results obtained in the field was given, and a diagrammatical theorem was formulated.

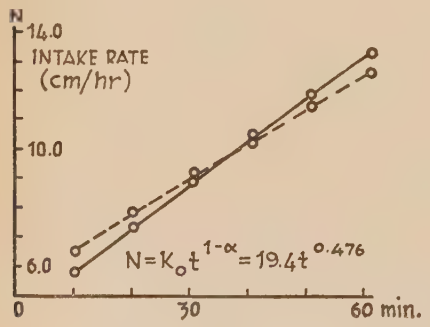


Figure 1

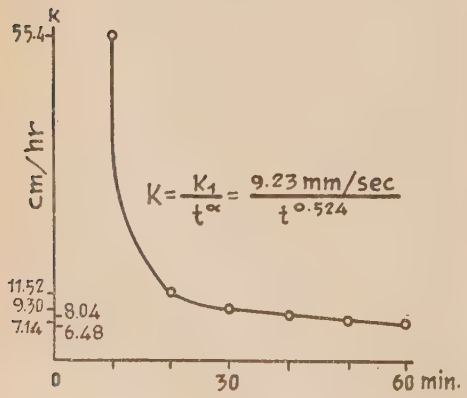


Figure 2

A method was presented for the collection of information on this important soil characteristic and for the analysis of results.

Data on the infiltration rate into a previously cultivated soil at Amir in the Huleh Valley and its change with time are presented in the form of an integral curve in Figure 1, and in the form of a differential curve in Figure 2, where N and K denote the cumulative infiltration and the intake rate respectively; α is a soil characteristic, normally varying between 0.3 and 0.8. Reproduced on a logarithmic scale, both these curves become straight lines.

The presented percolation data were obtained by a device consisting of a bottomless inner cylinder surrounded by an outer similar one, and automatic water supply to keep the water levels constant in both. In Figure 1, data are also given (broken line) as obtained under identical conditions with another simpler instrument working on the principle of the Boyle-Mariotte bottle.

M. Ram
Dept. for the Utilization of Water, Ministry of Agriculture

Amounts and Times of Water Application in Saline or Potentially Saline Soils

Equations were derived indicating the irrigation practices to be followed to prevent the salinisation of potentially saline soils. The discussion was restricted to conditions as are encountered normally, not taking into account extreme cases where full-scale reclamation or drainage operations may be required.

After enumerating the various possible sources of soil salinity, two cases of major importance were discussed in detail:

Case 1. Soil salinity is solely due to the use of saline irrigation water. For this case the equations were shown to supply the answers to the following three questions: what time interval should be allowed between successive applications of irrigation water; what amounts should be applied each time; when is there danger of solonetz formation.

Case 2. Soil salinity is caused by saline ground water close to the surface. For this case the equations indicate (a) in which cases to irrigate at a rate smaller than usual, (b) what kind of irrigation water may be used with safety in each instance.

Y. Rubin
Agricultural Research Station, Rehovot.

On the Problem of Active-Lime Content of Soils in Plantations

Chlorosis is a crop-disease which in most cases is connected with excess lime content of the soil. It is found that the tolerance of various vines and fruit trees differs. The latest findings show that

the decisive role in the appearance of chlorosis in crops is played by that portion of the lime which is part of the clay fraction. This portion is referred to as active-lime. The active-lime content of the soil is thus the criterion to be used when choosing the type of plantation for a given soil. Active-lime content is usually determined according to Droineau's method.

In order to determine quantitatively the effect of the active-lime content of soils on the development of different vines and fruit trees, a survey is now being carried out on existing vineyards and orchards and those in preparation.

Preliminary statistical analyses pertaining to restricted areas showed correspondence between active-lime content and total lime content in a soil only in 70 out of 100 cases; it might be pointed out, moreover, that, in cases where a correlation between these two is noticeable, the regression coefficients were found to vary considerably.

A. Porath
S. Gabay
Agricultural Research Station, Rehovot.

The Influence of Lime on the Decomposition of Soil Organic Matter

The majority of Israel's soils are calcareous and poor in organic constituents. Consequently, they need addition of organic material. This investigation was conducted to determine whether a connection exists between soil lime content and the decomposition rate of organic material added to the soil in the form of manure. Stable manure added to soil samples (2 parts to 100 dry-weight basis) was used in the experiments.

In one series a heavy, lime-deficient soil was lime-treated prior to the experiment, bringing its lime content up to 0%, 2%, 7.5%, 16%, 27% and 47%. In another series natural lime-containing soil samples were used. These samples came from the following localities and had the following lime-contents: Nahalal I (2%), Nahalal II (8%), Sdeh Nahum (20%), Massada (40%). The results of the experiments showed that the most effective influence of lime on the decomposition of organic matter occurred where the soil contained approximately 2% lime. Addition of lime beyond that shows the decomposition rate progressively in such a way that heavy lime applications make the decomposition rate less than in soils that are limeless. The decomposition-inhibiting effect of added lime is less pronounced in soils that have a natural lime content.

The widespread belief that a high lime-content in soils enhances the decomposition of organic matter was, therefore, shown to be erroneous.

Levy Carmel (Winnik)
S. Ravikovitch
Agricultural Research Station, Rehovot.

PROGRESS REPORTS

The Influence of Krilium-type Polymer Substances on Some Physical Soil Properties

The influence of the polymer, CRD-186, on soil aggregation was tested, and it was found that in most cases larger and more stable aggregates than in untreated soils were produced in soils by polymer treatment.

It appears that certain hydrophobic properties are also conferred on the soils by the polymer. Their storage capacity for water available to plants is reduced as a consequence of the treatment.

The polymer does not affect the lattice dimensions of the montmorillonite or kaolinite crystals, but its addition to the soils increases the sharpness of the lines in X-ray diffraction photographs.

Y. Hagin
The Hebrew University, Rehovot.

The Utilisation of Sewage for Irrigation Purposes

Sewage utilisation for irrigation was investigated in an experimental field in Nahalat Ahim, in Jerusalem, jointly with the Department for the Utilisation of Water and the Ministry of Health. The following aspects were investigated by the authors: (1) The effect of sodium salts in the sewage on soil salinity and soil physical properties. (2) Effects on soil pH. (3) The accumulation and decomposition of the organic matter. (4) Changes in the population of micro-organisms in the soil. (5) The effect of these factors on fertility of the soil and plant development.

Two kinds of sewage water were used: (1) Untreated sewage, after sedimentation. (2) Sewage subjected to air-oxidation in a drip-plant. Finally, control experiments were carried out using ordinary irrigation water.

The results of two years' experimentation show that:

(1) The content of chlorides and other soluble salts increased in all cases, especially in the upper 30 cm of soil.

(2) The biggest yields were on the plots irrigated with untreated sewage.

(3) The amount of raw proteins and carotenes was also highest in the plants reaped from plots irrigated with untreated sewage.

A. Muravsky
S. Ravikovitch
Agricultural Research Station Rehovot.

Zinc and Magnesium Deficiency in Citrus Plantations

Zinc deficiency apparently is caused by the incapability of citrus trees to extract zinc from the soil and to conduct it up through the trees' tissues. The role of soil properties is unknown. Zinc deficiency in citrus trees in Israel has been

noted especially where the trees grow on light-textured soils of slightly alkaline pH.

Experiments in groves near Rehovot proved that zinc compounds change quickly in this soil into forms that cannot be taken up by the trees. After application of 15 or 30 kg zinc salt/1000 m², no signs of improvement could be noted with respect to the colour of the leaves. Applications of four times that amount of zinc sulphate did produce some relief of the chlorosis; yet equally longer-lasting relief could be achieved by spraying the leaves directly with about 6 kg zinc sulphate.

Magnesium deficiency is less widespread than zinc deficiency and is confined to restricted areas only. The latter fact makes it probable that certain soil properties might be to blame. Observations in afflicted groves showed that all were planted on light-textured soils of slightly alkaline pH (7.5 to 8.2 in the upper 30 centimetres) and of lime content between 0 and 9%. These soils are poor in exchangeable potassium and rich in exchangeable magnesium. Yet the ratio between potassium and magnesium in the leaves of the afflicted trees was found to be the inverse of their ratio in the soil. It is obvious, therefore, that the amount of these nutrients in the soil is not the only factor that determines their uptake by the trees. Among other possible factors the moisture regime in the soil was found to be important: excessive irrigation increased the deficiency of magnesium very noticeably.

Both in the case of magnesium and zinc it was found that fixation processes make these ions unavailable if added like a fertilizer to the soil. Applications of 120 kg magnesium chloride or sulphate/1000 m² during two years failed to show any effect. 24 to 28 kg, on the other hand, if applied in the form of spray, turned leaf colour to green.

The mechanism of the fixation process of cations in light-textured soils should be investigated.

L. Heyman-Hershberg
Agricultural Research Station, Rehovot.

Physical and Chemical Research of Calcareous Rocks in Israel

Physical, mechanical and petrographic data of hard and soft calcareous rocks were collected in order to understand the influence of rock kind on pedogenesis of different soils in the mountain region of Israel.

Physical tests (specific gravity, texture, influence of water on structure of material, water absorption of rocks) showed differences in qualities between soft and hard calcareous rocks which may influence the mode of extraction and leaching by rain water.

X-ray analysis results have shown that hard rocks contain calcite and dolomite together with calcite, while soft rocks contain only calcite. Soils on hard rocks were found to contain montmorillonite, kaolinite and calcite, while soils on soft rocks contain calcite only.

Investigation of insoluble rock residue with the polarizing microscope proved that silicate minerals found in rocks were identical with silicate minerals found in soils formed on those rocks. The main minerals found were quartz, feldspar and clay.

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COLLOQUIA OF THE ISRAEL ASSOCIATION OF THEORETICAL AND APPLIED MECHANICS AND THE ISRAEL SOCIETY OF SOIL MECHANICS AND FOUNDATION ENGINEERING

On July 13-14, 1953, Colloquia were held at the Technion, Israel Institute of Technology, Haifa, by the Israel Association of Theoretical and Applied Mechanics and the Israel Society of Soil Mechanics and Foundation Engineering.

The following lectures were presented at the Colloquium for Theoretical and Applied Mechanics on July 13:

Prof. Felix Bloch: Nuclear Magnetism

Prof. M. Reiner: On Volume-Viscosity

Dr. Z. Rigbi: Vortex Development in Elastic Fluids

Miss I. Brown: Use of Physical Components in Tensor Analysis

Prof. F. Ollendorf: Principles of Ion Acceleration by Radiation Pressure

Mr. N. klein: Theory of Compressed Cables with Non-circular Section.

On July 14, 1953, the following lectures were presented in preparation for the Third International Congress of Soil Mechanics and Foundation Engineering (August 1953 — Switzerland):

Eng. I. Zeitlin: Applicability of Soil Tests in Engineering Practice

Prof. H. Neumann: Loading Tests on Saturated Sand

Dr. M. Rim: Moisture Distribution in Soil above a Water Table

Eng. M. Ram: Behaviour of Ground Water in Some Places in Israel

The Israel Society of Soil Mechanics and Foundation Engineering was founded in 1949. The Israel Society is affiliated to the International Association, and its aim is to assist scientists and engineers to exchange information relating to soil mechanics and its applications. To this purpose, the Society organises seminars,

provides a link between the workers in this field in the country, and helps its members to participate in international meetings and publications.

The meeting discussed questions of organization. Prof. M. Reiner and Eng. M. Peleg, chairman and secretary respectively of the Israel Society, were delegates to the Third International Congress of Soil Mechanics and Foundation Engineering. Prof. H. Neumann was elected Chairman of the Society for the following year and Eng. M. Peleg was re-elected as secretary.

INDOOR CLIMATE

On the occasion of the mission to Israel of Mr. George V. Parmelee, visiting expert on behalf of the World Meteorological Organization and the UN Extended Programme for Technical Assistance, a meeting organized by the Meteorological Service for the discussion of problems of indoor climate of buildings and, in particular, problems of the Jordan, Beisan and Huleh valleys took place on August 21-22, 1953, at Beit Yerah on the shores of Lake Tiberias.

Mr. M. Gilead, Director Meteorological Service, presided and Prof. H. Neumann, Head, Techno-Climatological Station of the Technion, assisted. In the first of the three sessions Mr. J. Neumann reviewed results of experimental work carried out by the Meteorological Service in cooperation with other investigators (W. J. Wittkower, W. Koch, J. Frenkiel). Some of these projects were financed by the Research Council of Israel. Prof. H. Neumann spoke on the results of investigations conducted by the Technion's Techno-Climatological Station. The principal lecture was then delivered by Mr. G. V. Parmelee, Research Associate, Research Laboratory, American Society of Heating and Ventilating Engineers, Cleveland, Ohio, who discussed fundamental problems of heat flow and ventilation in buildings.

The second session was devoted to debate in which J. Shapiro, "Ohalo", reviewed some of the climatic and especially indoor climatic problems of the three valleys. He was followed by Messrs. Amiran, Davidson, Kahanov, Krasnolselsky, Landsberg, H. Neumann, J. Neumann, Parmelee, Thon and Yissar.

In a short final session, in a resume of the lectures and discussions, those measures which, by consensus of opinion, will lead up to some amelioration of indoor climate conditions were emphasized and the need for coordination of research including the physiological aspect was stressed. Information should be collected, exchanged and disseminated in a simple language addressed to those whose task it is to deal with building construction locally.

A second meeting designed for those connected with building activities in the Negev and particularly for representatives of the settlements of this region, was held on 14th September 1953 in Beersheba, where participants enjoyed the hospitality of the Mayor and the Municipal Council. Mr. G. Steinitz, Deputy Director, Meteorological Service, presided over the meeting. The first speaker, Mr. G. V. Parmelee, gave a comprehensive account of problems and methods of indoor climatic investigations in a hot and dry region. Dr. M. C. Shelesnyak (Weizmann Institute of Science, Rehovot) spoke on the physiological aspects of indoor climate in a hot and dry climate. Mr. J. Neumann reviewed some methods for improving indoor climatic conditions in buildings in the Negev by simple and inexpensive means.

The ensuing discussion and the questions put to the lecturers indicated the vital interest of the participants in finding ways toward improvement of indoor climatic conditions. As at Beit Yerah, so also at Beersheba, it was felt that simple and "natural" means may not be sufficient to improve conditions and that the time has arrived when the use of inexpensive mechanical aids such as attic fans and evaporative coolers in the Negev should be considered.

Other activities during Mr. Parmelee's mission included a visit to the Technion, a public lecture in Haifa and a professional seminar of 16 lectures by the visiting expert in Tel Aviv.

SEISMOLOGICAL OBSERVATORIES

Israel is located in two overlapping tremor zones: the East-West zone extending from the Maritime Alps through Italy, Greece, Turkey, Israel and Afghanistan to India, and the North-South zone which produces tremors in the rift valleys of Africa. The Jordan Valley is at the outer fringe of this zone.

Since Israel is located in an active seismic belt, intelligent planning for the development of the country must allow for detailed study of its seismicity. A UNESCO programme towards this end began in 1951 with a short visit by Prof. Beno Gutenberg of the California Institute of Technology, who recommended the establishment of two seismological stations, each equipped with Benioff short and long period vertical component seismographs. Purchases of these instruments and additional apparatus such as clocks and radios was made with UNESCO funds, and a fellowship was granted to an Israeli, Mr. Lomnitz, to study seismology for one year at C.I.T. Finally UNESCO arranged for Prof. Frank Press of Columbia University to spend approximately 11 weeks in Israel to select sites, install the equipment and provide additional training.

Under the supervision of Prof. Press, the

National Physical Laboratory of the Research Council of Israel established two seismological stations, one in Jerusalem and one in Safed. The sites were chosen on the basis of existing knowledge of seismicity of Israel, availability of technical personnel, accessibility, and freedom from excessive industrial vibrations.

The central observatory, Jerusalem, is located in the basement of the National Physical Laboratory which is responsible for the operation of the stations. An excellent vault has been constructed, consisting of separate seismometer and recording rooms. Sufficient piers and recording tables are available for three additional seismographs. The auxiliary station at Safed is located in a modest, but adequate vault on the grounds of the Hadassah Hospital. The maximum instrument sensitivity at both stations is limited primarily by storm microseisms.

Since installation of the equipment, rarely a day has passed that a tremor has not been recorded, most of these disturbances occurring in the seismic belt of which Israel is a part.

Additional instruments are planned for local construction. A horizontal component seismometer patterned after similar apparatus at Columbia University is nearing completion. This instrument is equipped for galvanometric and pen and ink recording.

An advisory council composed of representatives of the N. P. L. I., the Department of Applied Mathematics of the Weizmann Institute of Science, Rehovot, the Department of Geology of The Hebrew University of Jerusalem, the Geological Institute and the Meteorological Service will advise on general operation of the observatories and, it is hoped, will plan and participate in a research programme.

As a service of the Government and as a participant in the international network of seismological stations, the observatory expects to provide the following: 1) Accurate and continuous operation of the seismographs — timing accuracy to be maintained to at least a fraction of a second, owing to the of existence of a standard clock in the N.P.L.I. 2) Distribution of a seismological bulletin semi-annually to members of the international network. If possible, a fortnightly interim bulletin will be distributed to control observatories in exchange for a similar service. 3) Press reports will be made giving preliminary magnitude and location of all earthquakes felt in and near Israel shortly after occurrence. It will be advisable to maintain a similar service for destruction earthquakes occurring anywhere in the world. 4) Data, as available, will be furnished to engineers, architects, insurance companies, courts, etc. on seismicity of the country. Earthquake engineering is an important field to cover, but this will require more training and equipment than now available. 5) Precision and magnitude determination of earthquakes felt in Israel. 6) Macroseismic study of destructive or widely felt Israeli earthquakes in conjunction with Dr. Shalem of the Hebrew University.

The seismological observatories afford an opportunity for an extensive research programme. The following list of recommended projects represents fields either of special local interest or in which local scientists have special competence: 1) Instrumental seismology. 2) Delineation of active tectonic zones in Israel and neighbouring countries, including work on direction of fault movements from first motion studies of Near East seismograms. 3) Crustal structure under Israel, including sedimentary thickness determinations. Quarry blasts would be used, but additional field equipment is necessary. 4) Crustal structure beneath Mediterranean Sea: is it a true ocean or a foundered continental mass. Analysis of earthquake seismograms can provide the answer. 5) Research in the theory of microseisms originating in oceanic storms. This is a wide open field not without potential application to certain forecasting problems. 6) Detailed study of seismicity of the Near East. 7) Further development of the theory of seismic wave propagation.

INTERNATIONAL CONFERENCE ON SEMICONDUCTORS

Amsterdam, June 29th — July 3rd, 1954

The Netherlands Physical Society, with the support of the International Union of Pure and Applied Physics and UNESCO, is organizing an *International Conference on Semiconductors* to be held at Amsterdam from June 29 — July 3, 1954.

The following scientists (two of them with some reserve) will deliver lectures: J. Bardeen, W. H. Brattain, H. B. O. Casimir, F. A. Kröger, D. Polder, M. Schön, W. Schockley, R. A. Smith, H. J. Vink, H. Welker—on subjects such as bulk recombination; surface conductivity; surface trapping; surface recombination; intermetallic compounds; the band picture in polar and non-polar semiconductors; photoconductivity in semiconductors like PbS, PbTe, PbSe, ZnS, CdS; the application of general physical and chemical laws for the preparation of semiconductors with specific properties.

Discussions will be held in connection with these main lectures and there will be opportunity to discuss problems in more detail in sectional meetings. In these sectional meetings, short communications of about 15 minutes can be given.

Scientists who would like to participate in the conference or who want to give a scientific contribution should communicate this to the secretary (Dr. H. Vink, Floralaan 142, Eindhoven/Holland) as soon as possible. They will receive a detailed programme in due course.

THE BOTANICAL SOCIETY OF ERETZ-ISRAEL

On December 2, 1953, the 45th meeting of the Society took place at the Agricultural Research Station, Rehovot.

An obituary on Dr. Ephraim Hareubeni, pioneer botanist of Israel, was delivered by Prof. H. R. Oppenheimer (Rehovot). Dr. Hareubeni was known for his researches in the field of Palestinian plant lore—both in the old Hebrew scriptures and in the contemporary Arab folklore. He published many papers in this field, and his collection of Bible plants was widely known.

Two sessions were held in which the following lectures and reports were presented:

I. Reichert (Rehovot) gave a report on the International Congress of Microbiology held in Rome in September, 1953.

R. Kenneth (Rehovot) spoke on the "Introduction of *Psalliota bispora* to Cultivation in Israel"[1]. The common cultivated mushroom and *Psalliota campestris*, the common field mushroom, from which the former was once thought to be derived, differ in so many ways that today many authorities no longer consider them to be closely related. *Psalliota bispora*, although rare in most countries, is common in Israel, and bears a striking morphological resemblance to the common cultivated mushroom. This year *P. bispora* was grown in Israel under conditions identical with those indicated for the cultivated mushroom, and a high yield was obtained. This may be considered as further proof that they are closely related.

1. Kenneth, R. and Wahl, I., 1953, *Bull. Res. Counc. of Israel*, 3, 255.

Zafrira Volcani (Rehovot) spoke on "Bacterial Disease of Onions and Tomatoes". It has been found that an onion leaf and tomato fruit disease is caused by the same bacterial organism. The pathogenicity to several hosts of both isolates of the organism was tested. The organism induced soft rot in tomato and pepper fruits, as well as softening of onion, tomato, pepper, potato and bean leaves under conditions of relatively high humidity. It also produced typical black pit lesions on citrus fruits. The optimal temperature for infection was 20-25° C. No infection occurred above 33° C and below 8° C.

Work is being carried out on identification of this organism which is very closely related to *Pseudomonas syringae* Van Hall.

E. Galun (Rehovot) spoke on "Factors Affecting the Emergence of Flax Seedlings: 1. Mechanical Injury; 2. Infection by *Trichoderma lignorum* (Tode) Herz". A direct relationship was shown between percent of fractured flax seeds in mechanically injured samples and percent emergence of seedlings.

It was found that infection by *T. lignorum* lowers percent emergence of the seedlings, a phenomenon more pronounced in fractured than in sound seeds. S. Panogen was found to be a very efficient fungicide against organisms attacking the fractured seeds.

Z. Bernstein (Kinnereth) spoke on "Experiments on Obtaining a Second Crop of Grapes in the Jordan Valley". In addition to the grape crop obtained in June-July in the Jordan Valley an attempt was made to obtain a second yield in November-December. Experiments were carried out in the vineyards of Kvutzat Kinnereth.

The above was suggested when in a Chasselas vineyard in November four ripe clusters of grapes were found on the upper 2 buds (the lower ones did not awaken at all) of a shoot whose end of 8 buds had been accidentally "pruned" — probably by a passing animal. Out of this observation developed the method of pruning the shoot down to 4-8 buds instead of to only the usual 2 and thereby exploiting, the same cane twice a year.

Other factors favourable to obtaining a second crop are the earliness of the first crop in the Jordan Valley and the persistence of high temperature through the 5-6 months between the first crop and the onset of the dormant season.

Using two varieties (Pearl of Csaba and Chasselas), canes of various lengths were pruned at different dates during August. With Chasselas the greatest yield—up to 1 ton/dunam—was obtained when shoots were pruned down to 8 buds and late in the month. The yield was obtained at the end of November and the beginning of December, and the shoot was then pruned normally down to 2 buds. No interference whatsoever occurred in the growth of the grape stocks which gave a normal crop in the usual season of the following year.

O. Shifriss (Rehovot) gave an account of the research carried out by Prof. Wellensiek and his students in Wageningen, Holland, on the nature of the physiological factor influencing stock-scion relationships.

Naomi Dotan (Feinbrun) (Jerusalem) related her impressions of the International Congress of Genetics at Bellagio, Italy (August 1953).

S. Klein (Jerusalem) spoke "On the Metabolism of Nitrogenous Substances during Germination". Little is known about the quality and quantity of free amino acids in the germinating seed—particularly during the first steps of germination. Thus experiments were carried out on germinating lettuce seeds. Using paper chromatography, it was possible to separate most of the acids, even when they appeared in very small quantities.

Ruth Levari (Jerusalem) spoke on "The Respiration of Germinating Seeds and the Effect of Inhibitors on Respiration"[1]:

1. Levari, R., 1953, *Pal. J. Bot., Jer. Ser.*, 6, in press.

Respiration of germinating wheat and lettuce seeds in water, 2,4-D and coumarin was studied. The concentrations used were those which inhibited germination of wheat and lettuce respectively.

The respiration in water during the time intervals measured may be divided into three phases according to its increase in intensivity. In wheat, both 2,4-D and coumarin stimulate respiration during the first phase, have no marked effect during the second phase and inhibit respiration during the third phase.

The R.Q. (respiration quotient) in water was found to be about unity during the 2nd hour. It reaches a maximum of 1.35 at the 8th hour and falls to 1.1 at the 22nd hour. The quotient is lowered by coumarin and raised by 2,4-D during the first phase. It is raised by both during the third phase.

Respiration of lettuce seeds in water differs from that in wheat in that the second and third phase occur later with lettuce. A temporary decrease in the intensity of respiration of lettuce is found at the end of the second phase. 2,4-D first inhibits and later stimulates, whilst the effect of coumarin is exactly the opposite. The R.Q. in water is about 0.8 during the 2nd hour; it falls to a minimum of 0.72 at the 14th hour and rises again to 0.795 during the 24th hour. The quotient is slightly lowered by 2,4-D and coumarin.

An attempt was made to indicate which processes cause the changes in respiration of germinating wheat as the result of the effect of the inhibitors.

CORRIGENDA Vol. III, No. 1—2.

Contents, 1. 11, p. 56, title: *for* absorption *read* adsorption.

p. 146, 1. 21: *for* absorptive *read* adsorptive. 1. 23: *for* absorbent *read* adsorbent, *for* chloride *read* chlorine.

p. 62, 1. 23 from bottom: *for* lpm *read* lps.

p. 66, ref. 25: *for* "*Ind. Chem. Eng.*" read *Ind. Eng. Chem.*

M. R. BLOCH and J. SCHNERB

On the Cl/Br-Ratio and the Distribution of Br Ions in Liquids and Solids during Evaporation of the Bromide-containing chloride Solutions Bull. Res. Counc. of Israel, 1953, 3, 151—158.

The Br/Cl-ratios in solids and liquids of the system H_2O-K^+-Mg^{++}-Cl-Br were determined and compared with those known in literature. Br/Cl- ratios in liquid and solid phases containing Carnallite were shown to be significant for the identification of Carnallite of different origins. The changes of Cl/Br- ratios in liquids and solids taking place during evaporation of Dead Sea water and of Mediterranean Sea water were determined. Especially the sudden changes of thr Cl/Br-ratio in the solid phase at invariant points of the evaporation diagram of Dead Sea water were investigated (Carnallite and Bischoffite points). The Cl/Br- ratios in different natural waters of the country were discussed and it was shown that the Cl/Br- ratio helps in the understanding of the nature of the Dead Sea, of Jebel Usdum and of salt layers found at the bottom of the Dead Sea.

COHEN, A.

The Effect of Different Factors on the Ascorbic Acid Contents in Citrus Fruits. I. The Dependence of the Ascorbic Acid Content of the Fruit on Light Intensity and on the Area of Assimilation. Bull. Res. Counc. of Israel 1953, 3, 159—170.

1. A study was made of the effect of light upon the concentration of ascorbic acid in citrus fruit grown under the conditions of Israel groves. No consistent differences in the scaorbic acid content of the juice were found between fruits from different sides of the tree The concentration of this constituent in fruits peckid from the central region of the crown was mostly up to 10 percent and in extreme cases up to 25 percent less than in peripheral fruits. The position of the tree had, on the whole, a more pronounced effect on the ascorbic acid content of the fruit peel than that of the fruit juice, and the greatest effect on that of the leaves. The sugar content of the fruit was affected by the position of the fruit to a lesser degree than that of ascorbic acid.
2. In the half of sunscalded fruit exposed to the full force of the sun's rays, the ascorbic acid content of the pulp and the peel were respectively 11 and 166 percent higher compared with the corresponding values for the shaded half.
3. Thinning out alternate rows of trees in an overcrowded orange grove resulted in an increase of 12 percent in the vitamin C content of the juice.
4. Short periods of change in weather conditions did not affect the vitamin C concentration of the juice.
5. Covering Shamouti orange fruits with black cloth three to five months prior to their attaining full ripeness, resulted in a 10 percent decrease in the ascorbic acid content and a reduction of 6 percent in the concentration of total soluble solids in the juice. In the peel the ascorbic acid content was reduced by two thirds and the sugar content by about 15 percent.
6. A reduction by two thirds of the intensity of light received by the leaves, produced no change in the ascorbic acid concentration in the juice of associated fruit, while the total soluble solids content decreased by 5 percent. The sugar and ascorbic acid concentration in the peel dropped approximately 30 percent in response to the shading of the foliage.
7. As a result of a drastic reduction in the number of leaves per fruit, the sugar content decreased by 57 percent in the peel and by 17 percent in the pulp. The corresponding drops in the ascorbic acid content amounted only to 37 percent and 7 percent respectively.
8. To explain the above observations, the following hypothesis is proposed. Ascorbic acid is synthesized in the orange peel under the influence of sunlight from assimilation products derived from the leaves and is then translocated from the peel to the pulp.

AVNIMELECH, M. and REISS, Z.

On the Upper Cretaceous and Tertiary Stratigraphy of a Boring near Beth-Govrin (Israel), Bull. Res. Counc. of Israel, 1953, 3, 171—176.

The log of a boring, 404 m deep and situated almost in the midst of a synclinal structure of the Beth-Govrin region (Israel is analysed and discussed, and the foraminiferal fauna partly listed. The boring disclosed thin remnants of Upper Neogene, lying discordantly upon an almost complete, possibly continuous Eocene series; below, the following units have been recognized: Danian-Paleocene, Maestrichtian and finally the probable top of the Campanian.

STURM, F.

Possible Origins of Manganese Ore in the Negev, Bull. Res. Counc. of Israel, 1953, 3, 177—191.

Manganese ore in the Wadi Menayeh area is found in the top layer of the "Carboniferous" formation. It occurs mainly in concretionary form or is disseminated in well-defined beds in fine-grained sandstone or siltstone. A study of manganiferous varved sandstone revealed that manganese is more likely to occur in varves poor in silt and clay. It is assumed that porosity of the mother rock is one of the important factors determining the location of the ore. The ore is considered to be almost entirely syngenetic. Several possible origins are considered and on the basis of available data a hypothetical environment of deposition and genetic history is constructed.

GUTTER, Y. and LITTAUER, F.

Antagonistic Action of Bacillus subtilis *against Citrus Fruit Pathogens*, Bull. Res. Counc. of Israel, 1953, 3, 192—196

Two isolates of *Bacillus subtilis* were found to exert a marked inhibitory influence on various fungi, such as *Diplodia natalensis*, *Oospora citri-aurantii*, *Penicillium digitatum*, *P. italicum*, *Phomopsis* sp., and *Sclerotinia sclerotiorum*, which are among the principal causal agents of citrus fruit rots. Microscopic observations revealed conspicuous structural changes in the inhibited fungi. The active principle involved retained almost fully its fungitoxic properties in the crude extract and was found to be thermostable. The development of the bacillus was slightly inhibited by some of the fungi.

MOSCONA, A. and MOSCONA, H.

Development in vitro *of Embryonic Organ Rudiments on Heterologous Adult Tissue Derivatives*, Bull. Res. Counc. of Israel, 1953, 3, 197-200.

Limb and pituitary rudiments of the early chick embryo develop and differentiate in *in vitro* the typical manner when grown in a culture medium consisting of adult tissue derivatives from heterologous sources, in the absence of embryo extract. The explants were cultivated in a liquid culture medium by a modified watch-glass technique and supported on a cellulose membrane. The question of metabolic and serological adaptation of the embryonic tissues *in vitro* to the heterologous culture medium is briefly raised.

FELDMAN-MUHSAM, B.

Rhipicephalus bursa in Israel, Bull. Res. Counc. of Israel, 1953, 3, 201—206.

The different stages of larva, nymph and imago of *R. bursa* are described. Host relation is discussed.

STEINITZ, H.

The Freshwater Fishes of Palestine. An Annotated List, Bull. Res. Counc. of Israel, 1953, 3, 207—227.

1. A revised list of the freshwater fishes of Palestine has been prepared with the help of published reports as well as on the basis of recent research not yet published.
2. Twenty four species are listed as existing in Palestine.
3. The majority of the species is well known.
4. Three species are known from one specimen only.
5. The validity of two other species is questioned.
6. The systematic standing of three fishes is not yet determined in full. They are either under investigation at present or should be subjected to reexamination.
7. A list of five species is appended which, although mentioned in the literature, cannot be included in our faunal list.

SHMUELI, E.

Irrigation studies in the Jordan Valley I. Physiological activity of the banana in relation to soil moisture. Bull. Res. Counc. of Israel, 1953, 3, 228—247.

The reduction of soil moisture below two-thirds down to one-third of total available water in the root zone resulted in a significant decrease in the water and dry-matter content of the leaves and a decrease in the average daily stomatal opening (up to 25 percent). It also resulted in the lowering of the average daily transpiration rate (up to 72 percent) and of daily evapotranspiration from 7 to 2 m3 per dunam.

The osmotic pressure of the roots was significantly lower when soil moisture was below one-half of total available water as compared with osmotic pressure prevailing under conditions of higher soil-moisture content. In the leaves, the highest osmotic pressure and the lowest relative water content were recorded when the soil contained approximately three-quarters of total available water. The osmotic pressure of leaves is lowest when available water in the soil approaches depletion.

Conspicuous yellowing of leaves occurs when available water is down to one-third, but retardation in the unfolding of leaves sets in only with almost complete depletion of available water.

Examination of stomatal opening by means of infiltration tests performed between noon and 1.00 p.m. provides reliable information concerning the response of the plant to reduction of available moisture below optimum range, i.e. below two-thirds of total available water. Thus, infiltration tests provide a useful and practical indicator to the need for renewal of irrigation.

To Professor Albert Einstein,
on his 75th birthday,
this issue is dedicated with
the highest esteem and affection
of the scientists of Israel